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ABSTRACT

This publication provides supplemental information which can be used by the teacher to accompany each unit in the Regents Biology Syllabus. Each unit of the supplement addresses topics and understandings in the corresponding unit of the syllabus. These units are: (1) unity and diversity among living things; (2) maintenance in living things; (3) human physiology; (4) reproduction and development; (5) transmission of traits from generation to generation; (6) evolution; and (7) ecology. Topics listed in the supplement are keyed into major topics and understandings in the syllabus and are treated in three ways: suggested laboratory activities; suggestions for demonstrations; and importance for various careers. In addition, some of the laboratory activities can be used to foster the development of the 16 basic laboratory skills indicated in the introduction to the syllabus. (JN)

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REGENTS Biology RESOURCE UNITS

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Foreword

This publication provides supplemental information which can be used by the teacher to accompany each unit in the Regents Biology Syllabus. The information was suggested, collected, and collated by biology teachers and consists of Suggested Laboratory Topics (see below), Suggestions for Demonstrations and Motivational Techniques, and Career Information for Students.

> (Pursuant to Section 207 of the Education Law, Section 8.2(c) of the Rules of the Board of Regents states, "Only those persons who have satisfactorily met the laboratory requirements as stated in the State syllabus for a science shall be admitted to the Regents examination in such science." This Rule of the Board of Regents applies to all students whether regularly enrolled in a Regents science class or studying independently. For students with severe physical handicaps, admission to science Regents examinations will be considered on an individual basis. Questions pertaining to the admission of students with severe physical handicaps to science Regents examinations should be directed to the Chief of the Bureau of Science Education, New York State Education Department, Albany, New York, 12234.)

Use of the Supplement

Each unit of the supplement addresses topics and understandings in the corresponding unit of the syllabus. Topics listed in the supplement are keyed into major topics and understandings in the syllabus and are treated in three ways; suggested laboratory activities, suggestions for demonstrations, and importance for various careers.

The numbers after each topic in the supplement refer to the numeration and pagination of the specific topic in the syllabus. In addition, topics in the syllabus which are referred to in the supplement are starred (*).

Laboratory Skills and the Supplement

As indicated on page viii of the introduction to the Biology Syllabus, it is necessary for students to satisfactorily perform 16 basic laboratory skills. While the laboratory activities suggested in the supplement are not required and by no means represent a complete series of laboratory activities, it is possible for the teacher to utilize some of the activities in working toward the development of the 16 skills. Referral to laboratory manuals or other references for complete instructions is necessary. A chart on page x of the Biology Syllabus can be referred to for cross referencing appropriate laboratory activities for each skill.

Errata

Because the biology syllabus was revised prior to the editing and keying of topics in the supplement, a number of topics referred to in the supplement were not starred in the syllabus. The following topics in the syllabus which are addressed in the supplement should be starred:

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Many biology teachers in New York State produced or developed the resource materials in this supplement which were, in turn, compiled by Nancy A. Will, Vestal High School. Douglas S. Reynolds, Chief and Thomas A. Boehm, Associate, Bureau of Science Education and Barry Jamason, Associate, Bureau of Curriculum Development coordinated the development of the syllabus. Margaret Ann Hasselwander aided in the preparation of the manuscript.

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Unit I - Unity and Diversity Among Living Things

Unit I— Unity and Diversity Among Living Things

SUGGESTED LABORATORY TOPICS	SUGGESTIONS FOR DEMONSTRATIONS AND MOTIVATIONAL TECHNIQUES	CAREERS

(1) Classification [II, A, B, C: p. 3]

Objective -
The students should be able to relate structural similarities to a classification scheme.

Suggested Approach -
Using specimens of plants and/or animals which are either preserved, embedded, or hand collected, have students devise a method of grouping, classifying according to kingdom, phylum, and in some cases, class.

(1) Classification

a) Collect a variety of plants and animals, keys, inanimate objects, etc., to elicit the theme of unity and diversity and to establish some simple method of classification.

b) Organism comparison at early stages: Collect (obtain from supply company) live, fertilizable eggs of several species of frogs, toads, and salamanders and have students note and compare the early stages of cleavage and development (as a basis for classification).

(1) Classification

Career/Education Years	Subject Area
Horticulturist/4	Grows and maintains plants.
Landscape Architect/4-5	Conceptualizes, plans, and implements landscapes.
Landscape Consultant/ 4, on-the-job	Plans gardens, landscapes for residential and commercial residences.
Museum Curator/4	Creates panoramas and displays.
Taxidermist/on-the-job	Mounts skins, showing relationship between form and function. Does artistic restorations.

(2) Monera, Protista, Fungi [II, B; p. 4]

Objective -
The students should observe examples of protista, monera, and fungi and be able to recognize and classify several types of unicellular organisms such as spirogyra, ameba, paramecium, bacteria and bread mold.

Suggested Approaches -

a) Cultures of ameba and paramecia may be obtained from biological supply companies.
b) Collect pond water and observe unicellular organisms that may be present.
c) Culture bread mold (bread without preservatives) or have students culture at home and bring to school.
d) Start hay infusions by having students place small amounts of soil, grass and water in disposable plastic containers and observe protists present after one to two weeks.

(2) Monera, Protista, Fungi

a) Project slime molds with a microprojector to demonstrate examples of protists and to emphasize life functions.

b) Use a microprojector to show a parasitic form of protozoa (Monocystis) present in the seminal vesicles of mature earthworms. Dissect out the seminal vesicles of a mature earthworm, mount in 0.7% NaCl solution and crush on a slide for examination.

c) Discuss varied commercial importance of monera, protista, and fungi:
1) food source for another animal.
2) drug manufacturing.
3) disease-carrying agents.
4) food "additives."
5) parts of food chains and webs.

(2) Monera, Protista, Fungi

Career/Education Years	Subject Area
Bacteriologist/4-8	Public health, private industry, research, hospital, laboratory.
Food Inspector/4	Tests food samples in private industry and government.
Mycologist/4-8	Tests food and water supplies; drug manufacturing.
Pharmaceutical Manufacturer/4-8	Researches bacterial activities of certain organisms.
Pharmaceutical Sales/4	Sells product and disseminates information concerning action of specific manufactured drugs.

SUGGESTED LABORATORY TOPICS	SUGGESTIONS FOR DEMONSTRATIONS AND MOTIVATIONAL TECHNIQUES	CAREERS	
e) Culture cheese molds. f) Prepare slides of algae obtained from fish tank.	Charts and bulletin boards can be prepared using student drawings and pictures from magazines or newspapers.	Pharmacist/4-5	Prepares, sells, and gives advice about prescribed and unprescribed drugs.

SAFETY SUGGESTIONS:

1) Students should not eat food in the laboratory.
2) Students should wash down their laboratory station at the end of the period.
3) Students should wash their hands thoroughly before leaving the laboratory.
4) Avoid inhaling spores if allergies are present.

(3) Microscope Parts and Usage
[III, A1, b; p. 6]

Objective -
The students should be able to identify the parts and demonstrate the proper use of the microscope, such as focusing under low and high power, carrying the microscope, proper cleaning of lenses.

Suggested Approaches -

a) The teacher may first demonstrate the parts of the microscope using either a microscope or a chart depicting a microscope. Then have students handle microscopes.
b) Students might diagram and label a microscope using their own as a model.
c) Using either prepared or self-made slides, the students should practice focusing the objects under low and high power.
d) Have students attempt scalar sketches of the materials that they observe.

(3) Microscope Parts and Usage

a) Show examples, using either actual equipment, if available, or photographs of:
- phase contrast microscopes.
- centrifuge
- dissecting microscopes.
- electron microscopes.

b) Demonstrate how these tools may be used for various purposes; for example:
- centrifuge: demonstrate the separation of particles by weight using either blood, mixtures of soil, or sand and water. (Attempt to use different colors.)

c) Show photomicrographs taken with the electron microscope (purchased or obtained free of charge).

d) Discuss the learning advances made possible by the use of photomicrographs.

(3) Microscope Parts and Usage

Career/Education Years	Subject Area
Criminal Investigator/ 1-4	Uses microscope to gather evidence in criminal cases.
Electron Microscopist/ 4-6	Uses electronmicroscope for study of ultra-structures.
Gem Cutter/ apprenticeship	Cuts gem stones for jewelry.
Histologist/4-8	Studies cell structure.
Medical Examiner/ 1-8	Examines body tissues.
Microscope Development/ 4-5, apprenticeship	Optics, construction of microscope lenses, grinding of lenses, electronics.
Repairer of Optical Equipment/on-the-job	Repairs and maintains microscopes.
Pathologist/8	Studies cells and tissue for diagnostic purposes.
Research (all areas of science)	Many areas of industry utilize microscopes for example, crystallography.

SUGGESTED LABORATORY TOPICS	SUGGESTIONS FOR DEMONSTRATIONS AND MOTIVATIONAL TECHNIQUES	CAREERS

(4) Slide Preparation [III, A, 1b; p. 7]

Objective -
The students should be able to prepare a wet mount slide of cells.

Suggested Approach -
Temporary Wet Mount -- have students prepare a wet mount slide of cells such as onion cells, cheek cells, lettuce epidermis, elodea.

Objective -
The students should be aware of the advantages of temporary mounts and permanently sealed mounts.

Suggested Approaches -

a) Temporary Sealed Mount -- students should prepare slides of cheek cells or other appropriate material and seal the edges of the cover slip with vaseline.
b) Permanent sealed mount -- prepare a slide of stained onion root tips or other appropriate material, add several drops of balsam, a cover slip and allow to dry.

(4) Slide Preparation

a) Demonstrate how to make a wet mount slide and show under a microprojector. Use protozoa from hay infusions, pond water, or purchased. Have students observe and discover why this is only a temporary mount.

b) Using a permanently prepared slide and a wet mount slide, have students discuss the advantages and disadvantages of each technique.

c) Mount a larger specimen such as hydra or planaria in a deep well slide to demonstrate the use of this slide for larger specimens.

d) Demonstrate the preparation of a hanging drop in a deep well slide.

e) Mount specimens such as hair or mold spores in glycerin. Have students look for any differences between specimens mounted in glycerin and specimens mounted in water.

(4) Slide Preparation

Career/Education Years	Subject Area
Cytologist/4-6	Studies normal and abnormal cells.
Laboratory Technician/2-4	Prepares slides for microscopic examination to aid in diagnosis.
Teacher/5-8	Teaches students of all levels to prepare slides.
Veterinarian/6-8	Diagnoses by examination of slides of materials/ cells of animals.

(5) Staining [III, A, 1b; p. 7]

Objective -
The students should be able to use stains such as iodine (lugols), methylene blue, or congo red to highlight cell structures.

Suggested Approaches -

a) Lugols -- prepare slide of onion cells or cheek cells and apply several drops of stain and a cover slip. Compare the stained cells to the unstained for any features that are visible with the stain that were not visible without stain.

(5) Staining

a) Using a paramecium, discuss and demonstrate the difference between vital stains, such as methylene blue and congo red, and stains which are absorbed and kill the cell immediately such as Lugols solution.

b) Demonstrate that certain cells, when alive, will not absorb stains.
1) Show live yeast on a microprojector, add congo red stain.
2) Boil yeast for several minutes to kill cells, then add congo red and have students observe the differences in the cells.

(5) Staining

Career/Education Years	Subject Area
Cytogeneticist/4-8	Research -- Studies stained nuclei and chromosomes.
Forensic Medicine/ 6-8	Prepares slides of cells taken from patient in attempt to identify cause of death.
Genetics Counselor/ 5-8	Prepares stained blood cells for chromosome analysis.

SUGGESTED LABORATORY TOPICS	SUGGESTIONS FOR DEMONSTRATIONS AND MOTIVATIONAL TECHNIQUES	CAREERS
b) Methylene blue -- 1) stain living paramecia with methylene blue and observe the nucleus and trichocysts. 2) stain cheek cells with methylene blue to observe the nucleus and granules of cytoplasm.	c) Prepare a slide of fresh blood and demonstrate on a microprojector; have students observe the cells. Stain a second slide and have students observe the stained white cells they could not see before. Discuss the value of stains.	Hematologist/6-8 — Studies specially stained blood cells for diagnostic purposes. Histologist/4-8 — Works in laboratory; identifies tissue types. Pathologist/6-8 — Usually works in hospital lab; identifies diseased tissues.

(6) Measurement [III, A, 1b; p. 7]

Objective -
The students should be able to determine the width of the field of view in mm. and micrometers under low and high power of the microscope.

Suggested Approaches -

a) Review the basic metric system measurements, convert meters to centimeters, and millimeters into micrometers. Have students measure the diameter of a microscope field under low power using a transparent plastic ruler. Note in mm. and micrometers. Remove the ruler, compare the low power magnification with that of high power. Divide the diameter of the field under high power; i.e., 100x low power, 400x high power, 4x increase; divide by 4.

b) Using known field diameters under both powers, estimate the diameters of individual cells. Use examples such as elodea or onion in which cells are located in contact with each other. Single, isolated cells such as paramecium or isolated cheek cells should also be observed and sizes estimated.

(6) Measurement

a) For an exercise in measurement, a wide variety of diverse sizes can be drawn on the chalkboard or overhead projector for students to measure in centimeters, millimeters, and micrometers.

b) Inchworm, mealworm, or ant races -- small organisms can be placed in test tubes, the test tubes loosely stoppered and then placed flat on tables to provide students with an opportunity to measure the distance traveled in a unit of time. Measurements can be made in centimeters or millimeters and then be converted into micrometers.

c) Have students determine the diameter of the field of view of a microprojector. Place diverse specimens (cells or organisms) on the microprojector stage and have students determine their actual size and their total magnification.

d) Have students determine the actual size of onion cells in micrometers. Prepare a piece of onion tissue one centimeter square for projection by a microprojector. Have students estimate, and then count, the number of cells present in a one centimeter square sample.

(6) Measurement

Career/Education Years	Subject Area
Bacteriologist/4	See Section (2).
Dental Assistant/2-4	Aids dentist or orthodontist with the professional care of teeth.
Pharmacist/4	Prepares prescription drugs.
Virologist/4	Identifies viruses as a cause of disease. Studies virus genetics.

SUGGESTED LABORATORY TOPICS

(7) Cell Structure [III, A, 1c; p. 7-8]

Objective -

The students should be able to (a) identify plant and animal cells, and (b) observe and identify the following structures:

- cell wall
- cytoplasm
- chloroplasts
- nucleus
- cell membrane

Suggested Approaches -

a) Have students prepare and examine cells from a variety of plants, animals, protista, moneras, and fungi.

Plants	Unicellular
lettuce epidermis	bread mold
onion skin	protococcus
elodea	paramecium
cork	

Animals

human cheek cells
frog blood
frog epidermis

Have students observe and identify the structures visible under the light microscope: nucleus, cytoplasm, cell membrane; and cell wall and chloroplasts, if applicable. Compare the various cells, note the structures common to all and classify as plant, animal, protista, moneran, or fungi.

b) Add several drops of salt solution to slide as plasmolysis occurs so that cell wall is more readily observed.

c) To show both unity and diversity in cell structure, students can compare specialized cells such as:
   -- smooth muscle cells (frog)
   - striated muscle cells (frog)
   - nerve tissue cells (chicken, cow brain, sheep, human)
   - blood cells (frog)

SUGGESTIONS FOR DEMONSTRATIONS AND MOTIVATIONAL TECHNIQUES

(7) Cell Structure

a) Construct a "model" of a cell using a plastic bag filled with gelatin. Place various small objects into the gelatin to represent organelles.

b) Placing the "gelatin cell" in a plastic container simulates a plant cell.

c) Show electron micrographs of various organelles.

d) Have students prepare chart showing organization of cells into tissues, organs, and organ systems.

e) Take an old clarinet or saxophone reed and place it on the microprojector, focusing on the thin end. Ask students what the structures appear to be. (Cells)

f) To observe specialized cells, such as ciliated epithelial tissue cells, obtain a live clam, open the shell and peel off thin bits of tissue from the edge of the gills or mantle. Mount on slide in a drop of liquid from the clam and project on a screen.

g) Using specific stains, demonstrate different organelles, for example:

   Janus green - Mitochondria
   Aceto-orcein - Nucleus, nucleolus

h) To demonstrate streaming of cytoplasm in slime molds, culture slime mold in the dark for several days. Make a wet mount of plasmodium; do not use cover slip. Observe the mold and its reactions to being touched with a hot needle, to acid, or to a small fragment of ice.

i) Discuss the development of the cell theory referring to original readings.

CAREERS

(7) Cell Structure

Career/Education Years	Subject Area
Botanist/4-8	Researches plant growth development, and disease.
Cytologist	See sections (3) and (4).
Medical Examiner/ 5-8	Studies cells, tissues, and organs of humans to determine causes of death.
Medical Illustrator/ 5-8	Creates diagrams for medical and science textbooks, charts, and films.
Medical Secretary/ 1-2	Records data referring to case histories of patients.
Pathologist/6-8	Studies tissue samples to aid in diagnostic work.
Zoologist/4-8	Researches and studies various animals.
Histologist/4-8	Prepares and identifies plant tissue slides.

SUGGESTED LABORATORY TOPICS	SUGGESTIONS FOR DEMONSTRATIONS AND MOTIVATIONAL TECHNIQUES	CAREERS

Objective -
The students should be able to observe the motion of the cytoplasm inside cells.

Suggested Approach -
To observe cyclosis, prepare slides of elodea, ameba, or slime molds. Observe and describe. Change conditions of light and temperature. Note reaction.

(8) Chemical Composition of Organisms [III, B 1 & 2; p. 9-13]

Objective -
The students should be able to determine the percentage of water by weight in living organisms.

Suggested Approaches -

a) Weigh a 100 gm. sample of peeled, sliced raw potato. Heat for several hours at 150°F. Weigh sample. The difference between original and dry weight can be used to compare the water content percentage.
b) Repeat with other types of tissue such as watermelon and meat to compare water content.

Objective -
The students should be able to determine the presence of sugars, starches, fats, proteins, and salts in living material by testing with specific reagents.
1) sugar - Benedicts or Fehlings solution.
2) starch - iodine
3) fats - paper test
4) protein - Biuret solution or nitric acid
5) salts - silver nitrate

Suggested Approaches -

a) Prepare standard solutions of sugar, starch, protein, fat, and salt. Test with the reagents (or paper) listed above to determine types of reactions for each compound.

(8) Chemical Composition of Organisms

a) Display a chart of chemical elements present in cells. Place specimens in small labelled bottles and wire to peg board. Use empty bottles to represent colorless gases. Indicate proportion of each element on a chart.

b) Demonstrate presence of water in cells by heating small specimens of any tissue in test tubes and note condensation on side of tube. Safety with use of flame and proper handling of hot glassware should be emphasized.

c) Students can build models of organic molecules using:
- commercially purchased molecule building kits.
- styrofoam balls and toothpicks.
- marshmallows, gumdrops.
- tinkertoys or other materials that can be found around the home or school.

d) Use molecular models of monosaccharides and fatty acids with empirical formulas to demonstrate the 2:1 ratio of H_2O in carbohydrates.

e) Use these models to demonstrate dehydration synthesis and hydrolysis.

f) Have students taste small samples of various monosaccharides to detect the differences in the tastes of various isomers.

(8) Chemical Composition of Organisms

Career/Education Years	Subject Area
Bacteriologist/4-8	See Section (2).
Biochemist/4-8	Research in private industry, hospitals, universities, and governments.
Dietician/4	Plans diets for various chemical needs of the body.
Food Inspector/2-4	See Section (2).
Horticulturist/2-4	Maintains plants in botanical gardens.
Pharmacist/4	Prepares prescription drugs.
Plant Nursery Manager/ on-the-job	Develops and maintains conditions which facilitate the development of healthy plants.

SUGGESTED LABORATORY TOPICS	SUGGESTIONS FOR DEMONSTRATIONS AND MOTIVATIONAL TECHNIQUES	CAREERS

b) Bring in a variety of organic matter to be tested for the presence of the compounds. For example:

meat	peanut
apple	onion
potato	orange
carrot	lettuce
rice	egg (yolk and white)

(Emphasize all above products were either once alive, or a part or product of a living organism.

g) Demonstrate the presence of protein using the Xanthoprotein test. Place one half teaspoon of solid food in a test tube, add an equal amount of concentrated nitric acid, boil, pour off acid, rinse with water and neutralize with ammonium hydroxide. Emphasize SAFETY with the use of acids and heat.

(9) Enzyme Activity [III, B, 3; p. 14-15]

Objectives -

The students should be able to:

1) Show the use of control procedures in an experiment.
2) Collect, interpret, and graph data.
3) Use a thermometer.
4) Measure volume of liquids to nearest mm, cc.
5) Observe and detect results of enzyme action.
6) Determine the relationship between temperature and enzyme action.

Suggested Approaches -

A number of different labs could be utilized to develop one or more of these skills:

a) To show the action of amylase in saliva on starch. Use boiled and unboiled saliva to test for its action on starch in plain crackers or matzoh. (Refer to a lab manual for specific instructions.)
b) Substitute a preparation of commercial diastase for the saliva, or starch paste can be substituted for crackers. Follow procedures in lab manual.
c) Fresh pineapple juice contains the enzyme bromelian (splits proteins)
   1) obtain fresh or frozen pineapple juice concentrate, add to test tubes containing boiled egg white or gelatin.

(9) Enzyme Activity

a) Demonstrate the lock and key analogy of enzyme activity using models made of wood, oaktag, cardboard, flannel board, or old jigsaw puzzle pieces.

b) Set up a demonstration using a mixture of starch paste and Lugol's solution. Add diastase. The loss of blue-black color indicates starch breakdown.

c) Demonstrate the use of an inorganic catalyst such as manganese dioxide.

d) Demonstrate how powerful enzymes are by their effect when diluted.
   1) prepare 0-1 - 0.2% solution of diastase.
   2) by serial dilution continue by one half for 5-10 times. Test each dilution to determine the ability of diastase to digest starch.

e) Demonstrate the effects of temperature on protein coagulation by boiling egg whites or gelatin. Relate this to the effects of high temperatures on enzymes.

f) Demonstrate the effects of temperature on enzyme activity by keeping small samples of milk at various temperatures for several days. Relate practical reasons for refrigeration.

(9) Enzyme Activity

Career/Education Years	Subject Area
Dairy Farmer/on-the-job	The proper handling and storage of milk at specific temperatures is required to prevent spoilage both at the farm and at the retail outlet.
Dietician/4	Specializes in planning diets to meet the nutritional requirements of different groups of people.
Farmer-Rancher/on-the-job	Attempts to control the enzyme activity required for the production of certain types of livestock feed (grass and corn silage).
Food Industry, Canning-Frozen Foods	Exercises proper care in the preparation of canned or frozen foods with regard to temperature.
Grocery Store Manager/ on-the-job	Uses proper temperature techniques to prevent spoilage of certain foods.

SUGGESTED LABORATORY TOPICS	SUGGESTIONS FOR DEMONSTRATIONS AND MOTIVATIONAL TECHNIQUES	CAREERS	
2) control: boiled or canned pineapple juice added to tubes containing boiled egg white or gelatin. 3) add toluene (to prevent spoilage). Observe over several days. NOTE: What can happen when fresh pineapple is added to gelatin? d) Test for the action of catalase (present in tissues such as liver or potatoes) on hydrogen peroxide. Grind up small amount of liver, place in test tube, add H_2O_2 and test gas released for presence of O_2. Boil liver and repeat. e) Graph rate of enzyme activity vs. temperature by setting up solutions of diastase and starch and maintaining at various temperatures ranging from 1° to 45°C and testing at timed intervals for rate of enzyme activity.	g) Demonstrate specificity of enzyme by showing that pepsin, for example, will not digest starch. h) Demonstrate another type of reaction caused by enzymes, coagulation. The enzyme renin coagulates milk. Crush a junket tablet (contains renin), add to milk in test tube, and warm gently. Let cool. Boil milk, then add junket. Let cool. Compare reactions.	Home Economist/4 Nurse; Practical, Registered/1-4	Uses a working knowledge of the chemical content of foods to determine the most efficient and effective ways to prepare and store food. Patient care.

Unit II - Maintenance in Living Things

Unit II--Maintenance in Living Things

SUGGESTED LABORATORY TOPICS

(1) Nutrition [I, A, 1; p. 20-23]

METHODS OF NUTRITION: AUTOTROPHIC AND PHOTOSYNTHESES

Objective -
The students should be able to observe that green plants produce carbohydrates.

Suggested Approach -
Test leaves from plant such as spinach, parsley, bean plant, for presence of sugar and starch with Benedict's or Fehling's solution and iodine.

Objective -
The students should be able to extract and separate the various pigments present in leaves.

Suggested Approach -
Extract pigments from spinach leaves and separate pigments by paper and/or thin layer chromatography.

Objective -
The students should be able to determine the factors involved with the process of photosynthesis.

Suggested Approaches -

a) Chlorophyll -- boil variegated leaf in water, then alcohol, and test for presence of starch.
b) Observe chloroplasts in green plants such as elodea or lettuce.
c) Light -- cover one portion of leaf or leaves with opague paper, or place in dark. After several days remove leaves, test for starch (stress control).
d) Carbon Dioxide -- Test several leaves on plants kept in light for sugar and starch. Coat top of some leaves with vaseline, coat bottom of others with vaseline. After one day, remove leaves and test for sugar and starch.

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SUGGESTIONS FOR DEMONSTRATIONS AND MOTIVATIONAL TECHNIQUES

(1) Nutrition

a) To distinguish between autotrophic and heterotrophic nutrition, make two sets of three sealed tubes containing: snail only, snail and elodea, elodea only, and place one set in light and one set in dark. Observe after several days.

b) Demonstrate CO_2 used in photosynthesis. Bubble breath through test tube containing phenol red or bromthymol blue. Place water plant in tube and let stand for one-half hour. Use control.

c) To show O_2 is released, place small amount of phosphorous in test tube with elodea. The phosphorous combining with O_2 releases forms of phosphorous pentoxide as a cloud around the phosphorous. Use control without plant.

d) Chlorophyll reflects green light. Extract chlorophyll from leaves, place in test tube and shine light through chlorophyll and prism. For control, shine light through prism only.

e) Recreate part of Priestly's experiment. Place a lit candle under one bell jar, and place candle and plant under a second jar.

f) Place one plant under bell jar. Seal. Place second plant and desiccant under bell jar and seal. Observe over several days.

g) Demonstrate model of glucose molecule and polysaccharide with molecule kits, styrofoam balls, etc., as suggested in Unit I resources.

h) Show effects of different wavelengths of light on growth of seedlings.

CAREERS

(1) Nutrition

Career/Education Years	Subject Area
Gardener/0-4	Maintains gardens of home and industry.
Horticulturist/4	Works at a botanical garden.
Landscape Architecture 4-5	Arrangement of outdoor areas according to intended use and harmony of design.
Nursery Worker/ 0-4	Maintains plant specimens.
Oceanographers/ 4-6	Investigates oceans as source of valuable food.
Park Naturalist/4	Promotes conservation in national and state parks; performs research in conservation of plants and animals.
Physicist/4-8	Studies the physical factors affecting plant growth and food production.
Plant Nursery Management/0-4	Maintain, grow plants for sale, advise on proper plant for intended area.
Plant Pathologist/ 4-8	Studies the causes of plant diseases.
Plant Physiologist/ 4-8	Studies structure and functions of plants.
Plant Technician/ 2-8	Cares for plant specimens and regulates plant growth.
Research Radiologist/	Uses radioactive materials experimentally in plant studies.

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SUGGESTED LABORATORY TOPICS	SUGGESTIONS FOR DEMONSTRATIONS AND MOTIVATIONAL TECHNIQUES	CAREERS	
e) Products released as a result of photosynthesis: 1) H_2O -- place cobalt chloride paper on leaves, remove after one day, observe change. 2) O_2 -- place elodea in inverted funnel, with test tube of water over funnel, and keep in light. Collect O_2 by water displacement, test with glowing splint. Objective - The students should be able to measure and graph the effect of light intensity on the rate of photosynthesis. Suggested Approach - Place water plants under inverted funnel with collection tube. Position lights at various distances; after five minutes, count and record oxygen bubbles escaping. Graph number of bubbles per second vs. distance from light source.		Tree Surgeon/ apprenticeship	Prunes, trims, and protects plants.
HETEROTROPHIC (I.B, 1; p. 24-27) Objective - The students should be able to identify preformed organic compounds used as foods. Suggested Approaches - a) Test known solutions of sugar, starch proteins and fats with Benedict's, Lugol's, Biuret solution, and paper test. b) Test a variety of foods for the organic molecules listed above. Objective - The students should be able to observe, detect and understand the importance of enzymes in heterotrophic nutrition. Suggested Approaches - a) Test effects of diastase on starch, using either starch solution or foods containing starch.	a) Demonstrate "lock and key" analogy of enzyme action by using models made of plywood or other appropriate materials, such as jigsaw puzzle. b) Demonstrate dehydration synthesis by cutting two sponges into hexagons to represent glucose, clamp together in vise until dry (will stick together). Hydrolysis: place dried "disaccharide" in water (will separate). c) Demonstrate fat digestion using oil, bile salts, and pancreatin. d) Observe feeding response in Hydra by adding glutathione to water. e) Compare adaptations of mouth structures for ingestion in earthworms, grasshoppers, and frogs. f) Compare tooth structures of a variety of animals and relate to mechanical digestion.	Anatomists/4-8 Animal Husbandry/ 2-4 Animal Scientist/ 2-4 Bacteriologist/4-8 Bacterial Lab Technician/2-4 Biochemist/4-8 Conservationist (Wildlife)/4 Dietician/2-4	Studies structure of organisms. Breeding of animals. Works in biological supply houses. Cultures and identifies microbes. Preparation of media, equipment. Studies materials pathways and products. Studies plans, methods of conservation of wildlife. Prepares diet materials based on nutritional need.

SUGGESTED LABORATORY TOPICS	SUGGESTIONS FOR DEMONSTRATIONS AND MOTIVATIONAL TECHNIQUES	CAREERS

b) Test effects of pepsin on the digestion of proteins. Use commercial albumen, gelatin blocks or boiled egg white.
c) To show importance of large surface area for complete enzyme activity, set up two test tubes of egg white and papsin, one with large pieces, one with small pieces. Test digestion after several days.
d) Enzyme specificity: Add diastase to various solutions of disaccharides, proteins and fats; test for digestion.

Objective -
The student should be able to observe and compare ingestion and digestion in various organisms.

Suggested Approaches -

a) Protozoans-Paramecium: Add yeast stained with Congo red. Ameba: Feed small paramecium.
b) Hydra: Add daphnia to hydra and observe ingestion.
c) Dissection and comparison of the alimentary canals of earthworms and grasshoppers.
d) Heterotrophic plants: Grow fungi (such as Rhizopus nigricans) on nutrient agar or bread, observe over period of several days to observe liquification.

g) Demonstrate denaturation or coagulation of protein by comparing unboiled egg white to boiled.

h) Peristalsis can be observed in live earthworms. Add acetycholine to surface of digestion tube to speed up or add adrenalin to slow down.

i) Bring in some examples of insectivorous plants and demonstrate their digestion of proteins.

j) Illustrate lack of chlorophyll in heterotrophic plants, such as mushrooms or Indian Pipe.

k) Obtain a mushroom growing kit and set up in dark area of classroom.

l) Feed hydra daphnia and observe process of ingestion and digestion.

Career/Education Years	Subject Area
Entomologist/4-8	Studies and cares for insect specimens.
Exterminator/0-2	Removes unwanted animals.
Food Inspector/2-4	Works with engineers, chemists, and health workers to insure compliance with safety regulations governing food.
Food Researcher/ 4-8	Analyzes food content and breakdown products.
Lab Technician/2-4	Prepares lab materials for research.
Nutritionist/2-5	Examines the bodily processes through which food is utilized and transformed into energy.
Pharmacologist/4-8	Conducts tests on animals to determine the effects of drugs on the digestive system.
Parasitologist/4-8	Detects and treats parasite infections.
Zoologist/4-8	Care of animals. Dissects animals, conducts experiments in natural settings.

(2) Transport [II, A, 1; p. 27-28]

Objective -
The students should be able to identify the processes of transport and relate these processes to physiological activities in living organisms.

Suggested Approaches -

a) Diffusion: Fill three dialysis tubing bags with three different solutions; sugar, starch and starch with diastase. Test water outside bag for presence of starch and sugar.

(2) Transport

a) Place several drops of food color in four beakers of water. Let one stand, stir another, put ice water in the third and hot water in the last. Compare rates of diffusion.

b) Repeat with a solid potassium permanganate.

c) Demonstrate diffusion of a gas through a gas by placing either peppermint oil or perfume on exposed surface and have student note time of detection.

(2) Transport

Career/Education Years	Subject Area
Anesthetist/4-8	Administers anesthetic and monitoring patient prior to, during, and after surgery.
Biomedical Equipment Technician/2	Installs, maintains, and repairs medical electronic equipment.
Cell Biologist/4-8	Research on cell membranes.

SUGGESTED LABORATORY TOPICS	SUGGESTIONS FOR DEMONSTRATIONS AND MOTIVATIONAL TECHNIQUES	CAREERS

b) Active transport: Add Congo red to both heat killed and live yeast cells to show difference.
c) Osmosis: Cut and weigh cores of potato, place in distilled water and varying concentrations of sucrose. Remove, dry, and weigh.
d) Phagocytosis: Add drop of yeast stained with Congo red to ameba on slide.

Objective -
The students should observe the effects of various concentrations of salt solutions on cells and explain in terms of osmosis.

Suggested Approaches -

a) Place drop of blood on three slides, add an isotonic solution to one, to the second a hypotonic solution, and to the third, a hypertonic solution.
b) Observe elodea in pond water, then replace the pond water with salt solution.

d) Fill dialysis tubing bag with starch solution, place in beaker of water containing lugols solution, and observe.

e) Pour gelatin which contains phenolphthalein in large test tube, harden, and invert over ammonia.

f) Soak egg in vinegar, note swelling.

g) To show longitudinal and lateral transport as related to diameter and size of cells, fill several pieces of glass tubing of different core diameters with alkaline agar solution, place in phenol red solution, and note nigration in various tubes.

h) Construct an osmometer.

Career/Education Years	Subject Area
Clinical Chemist/5-8	Analyzes body tissues and fluids.
Medical Supplies Sales/2-4	Sells and instructs in the use of medical and surgical supplies.
Pharmacist/5-6	Dispenses medicines. Provides information to the public on health topics.
Pharmaceutical Sales/2-4	Sale and dispensing of information concerning use of pharmaceuticals
Therapist-Dialysis/ 2-4	Monitors patients on dialysis.

(3) Circulation [III, A-2, B; p. 29-31]

Objective -
The students should observe intracellular circulation (cyclosis) and the effects of change in the environment.

Suggested Approaches -

a) Observe elodea leaf on slide, vary temperature and intensity of light.
b) Observe movement of cytoplasm in leaf of plant.
c) Observe living ameba.

Objective -
The students should be able to observe structures involved in circulation in plants.

Suggested Approaches -

a) Observe root hairs in root tips: 1) of seeds germinated in clear agar; and 2) mounted in dilute methylene blue.

(3) Circulation

a) Observe circulation of blood in capillaries of goldfish tail.

b) Place stem of celery in dye and after 24 hours note movement of dye. Cut stem in several places to note movement through vascular tissues.

c) Split stem of a white chrysanthemum or a carnation about one inch. Place each half of stem in different color dyes and observe petals.

d) Discuss flow of sap in sugar maple trees and its collection. (If possible, plan field trip in local area to see this process.)

e) Demonstrate root pressure and rise of water up a stem by cutting off top of stem of young plant and attaching piece of glass tubing connected to plant by rubber hose.

(3) Circulation

Career/Education Years	Subject Area
Artist (Text Illustrator)/4-8	Draws model designs of plant structures.
Biophysicist/4-8	Studies the forces involved in the function of living things.
Botanist/4-8	Research in plant transport diseases, parasites affecting vascular tissues.
Cardiologist/ 4-12	Specializes in circulatory system structure and function.
Forester/2-8	Plans and manages the growth of forest for lumber and other commercial uses.

SUGGESTED LABORATORY TOPICS	SUGGESTIONS FOR DEMONSTRATIONS AND MOTIVATIONAL TECHNIQUES	CAREERS	

b) Observe cross section of monocot and dicot roots and stems. Locate and compare vascular tissues.
c) Test a variety of roots for presence of starch, indicating transport from leaves.
d) Observe cross section of leaf. Locate xylem and phloem in veins.
e) Study stomatal openings of a variety of leaves by peeling off lower epidermis. For patterns of guard cells and stomates, paint bottom of leaf with colorless nail polish, dry and remove.

Objective -
The students should be able to describe and contrast the adaptations for absorption and circulation in representative organisms.

Suggested Approaches -

a) Protozoans: To see cyclosis of food vacuoles feed yeast stained with congo red.
b) Place green algae on slide with hydra, observe circulation of algae in gastrovascular cavity.
c) Observe the circulation and pulse of an earthworm either anesthetized with five percent alcohol solution and dissected; or through skin while moving.
d) Observe cross section of intestine of earthworm and note adaptation for increased surface area.

f) Measure rate of transpiration by measuring radioactive phosphorous uptake. Place plant in lead shielded box, add radioactive phosphorous to soil, attach radioautotrophic paper to leaves, and watch for incorporation in test leaves with geiger counter.

g) Demonstrate action of stomates by inflating two longitudinal balloons, tie ends together to form oval, squeeze balloons, and observe opening of stomates.

h) Girdle young plant to observe effects of disruption of circulation.

i) Collect various types of leaves and compare structure and position of veins. Make carbon prints of leaves to compare.

j) Compare a variety of types of root systems in plants.

k) Illustrate capillary action by placing clear glass tubing of varying diameters in liquid.

Career/Education Years	Subject Area
Horticulturist/4	Maintains plants in botanical gardens.
Medical or Research Librarian/4-6	Catalogs information.
Nurseryman/4, on-the-job	Grows plants for commercial use.
Research Physiologist/4-8	Studies animal functions.
Teacher/5-8	Teaches principles of botanical science at the high school and college level.
Veterinarian/6-8	Treats animals.
Zoologist/4-8	Studies all aspects of transport systems in animals.

(4) Respiration [III, A, B; p. 32-37]

Objective -
The students should observe the use of ATP as a source of energy.

Suggested Approach -
ATP - Bioluminescence Kit (LAB-AIDS). Mix ATP with luciferin. Observe glow.

Objective -
The students should know that oxygen is necessary for aerobic respiration.

(4) Respiration

a) Using models of molecules, demonstrate how glucose can be broken down to pyruvic acid, then CO_2 and water.

b) Mix up a simple dough mixture of flour, sugar, water and yeast. Keep covered and warm. Demonstrate effects of fermentation.

c) Demonstrate that a candle needs a continuous supply of oxygen to burn. Place lit candle under bell jar or beaker.

(4) Respiration

Career/Education Years	Subject Area
Air Conditioning Mechanic (vocational training and/or apprenticeship)	Installs, maintains air conditioning equipment.
Anesthesiologist/ 6-10	Administers drugs and anesthetics during surgery.
Baker/apprenticeship	Retail or commercial preparation of breads.

SUGGESTED LABORATORY TOPICS	SUGGESTIONS FOR DEMONSTRATIONS AND MOTIVATIONAL TECHNIQUES	CAREERS	

Suggested Approach -
Soak pea seeds. Fill one test tube half full with boiled peas, one half full of unboiled peas. Cover each with cotton and potassium hydroxide pellets. Connect to manometer. Note changes as O_2 is used.

Objective -
The students should observe the end products of aerobic and anaerobic respiration.

Suggested Approaches -

a) Place sugar solution in each of two thermos bottles and add yeast to one stopper with two hole stoppers. Place thermometer in one hole. Place one end of glass tubing into second hole. Place other end into test tube of lime water. Record and graph temperature vs. time (over a two-day period) and note degree of change in lime water.
b) Aerobic respiration: Soak peas. Fill one tube half full of unboiled peas, and another with boiled peas. Stopper with one-holed stopper. Have glass tube extend into lime water or bromthymol blue.

Objective -
The students should observe the adaptations of leaves, stems, and roots for respiration.

Suggested Approaches -

a) Observe stomata in epidermis.
b) Observe air spaces in cross section of leaf.
c) Locate lenticils on stems of a variety of plants.

Objective -
The students should observe and compare the respiratory systems of various organisms.

Suggested Approaches -

a) Dissect a grasshopper and observe the spiracles and trachial tubes.

d) Show how oxygen supports combustion. Collect oxygen by combining at room temperature a 6% solution of hydrogen peroxide with manganese dioxide. Test the gas with a glowing splint.

e) Obtain small animal respiration chamber to measure heat released in respiration.

f) Prepare two test tubes with water and bromthymol blue. Add elodea to one and stopper both. Place both tubes in dark for 24 hours. Observe.

g) Place lime water in two jars. Suspend cheesecloth bag of germinating seeds in one, and a plain cheesecloth in second. Cover both. Observe after 48 hours.

h) Observe movements and rate of respiration in live grasshoppers.

i) Grow seeds in atmosphere void of O_2. Place in vial containing alkaline pyrogallic acid. Compare with normal.

j) Set up fermentation tube with yeast.

k) Prepare charts/bulletin boards depicting:
1) cellular respiration
2) analogous structures for respiration in plants and animals.
3) anaerobic respiration and importance to man.

Electro-Medical Equipment Repairer/ 1-2	Repairs equipment.
Exercise Physiologist/ 4-8	Studies relationship of exercise to body physiology.
Extra-corporeal Technologist/2	Operates cardiopulmonary bypass equipment.
Immunologist/4-6	Studies allergic reactions.
Inhalation Therapist/2-4	Relieves symptoms in people with respiratory disorders such as emphysema.
Radiologic Technologist/1-5	Operates x-ray equipment. (vocational/technical training: 1-5 years)
Respiratory Therapist/2-4	Provides respiratory therapy as physician instructs.
Wine or Beer Master/ apprenticeship	Prepares and tests alcoholic beverages.

SUGGESTED LABORATORY TOPICS	SUGGESTIONS FOR DEMONSTRATIONS AND MOTIVATIONAL TECHNIQUES	CAREERS

b) Observe goldfish and describe motions during respiration. Place several fish in different temperatures of water; observe and graph changes in rate of respiration.

(5) Excretion Process [IV, A, B; p. 37-39]

Objective -

The students should be able to name the metabolic activities of organisms and the waste products as a result of each.

Suggested Approaches -

a) Respiration -- refer to suggested laboratory #4, on end products of respiration.
b) Examine uric acid excreted by live grasshoppers.

Objective -

The students should be able to observe and compare adaptations in various organisms for the removal of metabolic waste.

Suggested Approaches -

a) Observe the functioning of contractile vacuoles in paramecium. Vary the concentration of salts in water and distilled water and note changes.
b) Dissect earthworm to find nephridia and excretory pores (hand lens) and grasshopper for malphigian tubules and spiracles.
c) Adaptations in plants: Compare stomate arrangement, number, and size. Place varying concentrations of sugar solution on slides of leaf tissues and observe changes in size.

(5) Excretion Process

a) Exhale on a cold dry surface and observe condensation on surface.

b) Demonstrate presence of CO_2 in exhaled air by bubbling breath into test tube containing lime water, bromthymol blue, or phenol red.

c) Set up covered terrarium to demonstrate the transpiration of excess water by plants.

d) Use overhead projection of plant cells showing large vacuoles, where toxic materials may be sealed off.

e) Demonstrate relationships between urea and ammonia. Add urease to urea -- ammonia is released and can be detected with phenolphtalien.

(5) Excretion Process

Career/Education Years	Subject Area
Biochemist/4-8	Studies chemical nature of waste materials.
Cytologist/4-6	Studies cellular structure of microscopic organisms.
Diagnostician/4-8	Identifies malfunction of excretory structure.
Physiologist/4-8	Experimental study of organic functions.
Radiation Technologist/2-4	Use of radioactive isotopes in tracing metabolic pathways.

SUGGESTED LABORATORY TOPICS

(6) Regulation [V,A,B; p. 39-43]

Objective -
The students should observe the responses of various organisms to external stimuli.

Suggested Approaches -

a) In representative organisms test for the positive or negative responses to such factors as light, gravity, mechanical stimulation, heat or cold, and chemicals (mild acid, base).
b) Observe the release of trichocysts in paramecium by adding dilute acetic acid to a culture while observing through the microscope.

Objective -
The students should identify the effect of plant growth regulators on plants.

Suggested Approach -
Apply plant hormones, such as IAA or gibberellin, to growing plant stems or roots and observe changes in growth.

Objective -
The students should observe the effects of hormones in animals.

Suggested Approach -
Add hormones such as adrenalin and norepinephrine to observe the effects of the heart beat of daphnia.

Objective -
The students should be able to observe and compare adaptations in various organisms for regulation and coordination.

Suggested Approaches -

a) Dissect an earthworm and/or grasshopper and identify the parts of their nervous system.
b) Remove portion of lens of eye of grasshopper. Observe under microscope.

SUGGESTIONS FOR DEMONSTRATIONS AND MOTIVATIONAL TECHNIQUES

(6) Regulation

a) Demonstrate these reflexes with a live frog:
   1) Hold a live frog in one hand; bring a glass rod near one eye. Observe blinking.
   2) Touch the "nostrils" -- watch response.
   3) Stroke throat, belly regions. Observe the clasping reflex in males.
   4) Stroke back and sides of a male to make it croak.
   5) Wash off any mucus present on the back of a frog and apply a cotton swab dipped in vinegar. Note scratching.

b) Obtain extract of the abdomens of ants. Place on paper to produce "trail." Observe other ants following "chemical trail."

c) Observe geotaxis in drosophila by inverting bottle.

d) Demonstrate sensitivity to touch in a mimosa plant.

e) Set up series of plants to illustrate tropisms.

f) Set up germinating seeds in test tube or petri plate to illustrate geotropism.

CAREERS

(6) Regulation

Career/Education Years	Subject Area
Conservationist/4	Care and protection of wildlife.
Experimental Biologist/4-8	Studies animal behavior.
Greenhouse Manager/ 4-6	Establishes levels of humidity and light levels for plant growth.
Horticulturist/2-4	Maintenance of plants.
Nursery Manager/0-4	Growth and maintenance of plants.

SUGGESTED LABORATORY TOPICS

(7) Locomotion [VI, B; p. 43-44]

Objective -
The students should be able to observe and describe locomotion in representative protozoans.

Suggested Approaches -

a) Observe a drop of living paramecium culture on a slide with cotton fibers. Add drop of carmine suspension.
b) Observe ameba under low and high power.
c) Observe locomotion in Euglena.

Objective -
The students should be able to observe the structures of invertebrates used in locomotion.

Suggested Approaches -

a) External: The students examine live specimens noting appendages and motion. Suggested specimens might include sponges, sea urchins, earthworms, crawling and flying insects. Preserved specimens can be used instead, but the type of motion can only be deduced.
b) Internal: Dissect earthworm and/or grasshopper and note type of musculature and arrangement.

SUGGESTIONS FOR DEMONSTRATIONS AND MOTIVATIONAL TECHNIQUES

(7) Locomotion

a) Prepare a mercury Ameba display on overhead projector, add crystals of potassium dichromate.

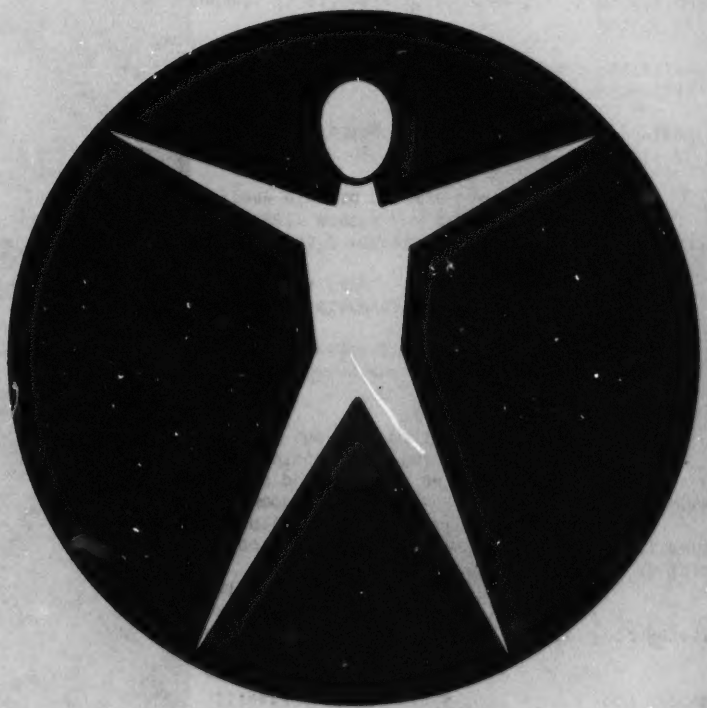
b) Display, using the overhead projector, the leg of a large grasshopper and the skeleton of a frog or other jointed legged vertebrate. Elicit student comparison of the relationship between muscle and skeleton in the two specimens and speculation about these arrangements to the type of locomotion in each case.

CAREERS

(7) Locomotion

Career/Education Years	Subject Area
Coach - Recreation Director/0-5	Guides individuals and/or teams in sports.
Exercise Physiologist/4-8	Studies relationships of exercise and muscle action.
Physical Therapist/ 4	Rehabilitates disabled people. Teaches use of and designs prostheses.
Physical Education Teacher/5-6	Conducts physical education programs in schools.

Unit III - Human Physiology



Unit III -- Human Physiology

SUGGESTED LABORATORY TOPICS

(1) Nutrition [I, A, B; p. 46-50]

Objective -
The students should be able to identify the six major classes of nutrients found in foods.

Suggested Approach -
Determine the presence of carbohydrates, protein, fats, minerals, vitamins, and water in some common food samples.

Objective -
The students should be able to critically evaluate the nutritional adequacy of a day's diet.

Suggested Approaches

a) Have each student record all foods eaten during the previous day and evaluate his/her diet by referring to information on recommended number of daily servings and dietary allowances of each food group.
b) Have students identify any problem with their food intake and make recommendations for improvement.

Objective -
The students should be able to determine how the body uses food for energy by calculating caloric values of common foods.

Suggested Approaches -

a) Have students calculate the caloric value of common food items using food composition tables to find the quantity of carbohydrates, protein, and fat for each food. For example:

Whole Milk, 8 ounces:

CHO	Protein	Fat
16.3 g	7.3 g	7.9 g
x 4 kcal/g	x 4 kcal/g	x 9 kcal/g
65.2 kcal	29.2 kcal	71.1 kcal

65.2
29.2
71.1
165.5 kcal in 8 ounces of milk

(one kilocalorie [kcal] is equal to one food calorie.)

SUGGESTIONS FOR DEMONSTRATIONS AND MOTIVATIONAL TECHNIQUES

(1) Nutrition

a) Prepare a list of food additives used to retard spoilage. Discuss why they work.

b) Have students investigate the use of diethylstilbestrol in feeding beef cattle. Illustrate with photos and prepare as part of a bulletin board.

c) Have students remove labels from a variety of packaged foods and discuss the type of information found on the label.

d) Students should collect articles or sources of information on nutrition from popular consumer magazines, weekly newspapers and professional nutritional journals, and discuss the reliability and validity of the information from these sources.

e) Discuss food poisoning and how temperature affects the micro-organisms responsible.

f) Review the role dietary carbohydrates may play in dental care.

g) Have students gently remove some dental plaque from their mouths and stain it with methylene blue to observe bacteria.

h) Have students plan a variety of different types of diets including vegetarian and ethnic.

i) Discuss the desirability of the inclusion of a variety of foods in the diet.

j) Have students investigate disease states or symptoms caused by excess or deficiency of nutrients and prepare bulletin board.

k) Have students investigate such issues as the importance of Recommended Dietary Allowances in the development of new products by industry, establishing guidelines for nutritional labeling, and establishing standards for public assistance programs.

CAREERS

(1) Nutrition

Career/Education Years	Subject Area
Dietician/4	Prepares diets based on nutritional needs.
Food Processor/0-4	Handling and preparation of food.
Food Researcher/4-6	Analyzes nutritional content of food.
Health Inspector (government)/0-4	Inspects kitchens and food samples.
Home Economist/4-6	Plans and prepares nutritionally balanced meals.
Home Health Aide/ 0-2	Aids patients in food preparation and personal care.
Nutritionist/4	Determines nutritional requirements and how they are met by foods.
Physician (Internist)/ 6-10	Diagnoses and treats ailments of digestive system.
Practical Nurse/ 6 months to 2 years	Cares for patients.
Veterinary Assistant/0-2	Aids veterinarian in care of animals.
Public Health Nutritionist/4-6	Aids in planning diets for public programs.
Home Economics Teacher/4-6	Teaches principles of nutrition, menu planning, and food preparation.
Food Technologist/4	Analyzes, prepares, preserves, and packages food.

SUGGESTED LABORATORY TOPICS	SUGGESTIONS FOR DEMONSTRATIONS AND MOTIVATIONAL TECHNIQUES	CAREERS

b) Have students measure caloric value of food samples with a calorimeter.

Objective -
The students should be aware of the importance of mechanical digestion.

Suggested Approach -
Determine the difference in the rates of digestion for large and small pieces of food. (Example: egg white and protease or cracker and diastase.)

Objective -
The students should be able to recognize the structures of the digestive system and their location.

Suggested Approach -
Dissect a vertebrate animal.

Objective -
Students should observe the activity of various enzymes of the digestive system.

Suggested Approaches -

a) Observe effects of salivary amylase on starch.
b) Observe effects of pepsin on protein.
c) Observe effects of pancreatin or intestinal proteases on an appropriate substrate.
d) Observe effects of bile salts on fat digestion.

l) Discuss obesity and weight loss as related to excessive consumption of energy.

m) Investigate the disorder anorexia nervosa (charts or bulletin board can be prepared in the process).

n) Discuss the role of food additives and their use.
1) aids in processing or preparation.
2) affect appeal characteristics.

o) Demonstrate emulsification of fats by mixing oil, water, and bile salts.

p) Demonstrate peristalsis by having two students stretch length of rope between them. One student snaps end of rope.

q) Discuss Beaumont's observation of digestion in the stomach.

r) Demonstrate the effects of pH on enzyme activity by setting up a series of tubes each containing an enzyme and substrate but varying in pH.

s) Projections on a rubber change mat can be used to represent villi.

t) Trace the digestion of a food such as a pizza slice, hamburger, or peanut butter sandwich.

u) Have students trace what happens to beer or other alcoholic beverages in the digestive tract.

(2) Transport [II, A, 1, 2, 3; p. 54-57]

Objective -
The students should be able to identify the parts of the human circulatory system and describe the structures.

Suggested Approaches -

a) Dissect a vertebrate animal and identify the major parts of the circulatory system.

(2) Transport

a) Observe parts of circulatory systems in a human torso model.

b) Observe parts of mammalian circulatory system such as heart or large blood vessels obtained from butcher or hunters. Dissect to show valves and chambers.

(2) Transport

Career/Education Years	Subject Area
Biochemist/4-8	Researches chemical nature of blood.
Biomedical Engineer/ 4-8	Designs systems to simulate organs; designs and installs patient monitoring equipment.

SUGGESTED LABORATORY TOPICS	SUGGESTIONS FOR DEMONSTRATIONS AND MOTIVATIONAL TECHNIQUES	CAREERS	
b) Study slides of cross sections of arteries and veins. c) Trace flow of blood through heart and major blood vessels. Objective - The students should be able to determine the effects of exercise on the circulatory system. Suggested Approach - Observe changes in blood pressure and/or rate of heartbeat before and after varying amounts of exercise and graph the result. Objective - The students should be able to recognize the various normal parts of the blood. Suggested Approaches - a) Observe a blood smear prepared with Wright's stain. b) Observe slides of blood disorders to illustrate changes in types and numbers of cells. c) Observe effect of hypo- and hyper-tonic solutions on blood cells by adding salt solution and distilled water. d) Determine the percentage of hemoglobin by comparing blood samples to standard hemoglobin chart. Objective - The students should be able to test for A, B, and O blood groups and recognize the importance of antigen-antibody reactions. Suggested Approaches - a) Test blood using anti-A and anti-B sera. b) Once blood types have been identified, mix different types on a slide and observe results. Blood for typing may be obtained from blood banks or supply companies.	c) Observe circulation in tail of a goldfish. d) Students can construct a model of a human containing "heart," major "blood vessels" of plastic tubing. e) Centrifuge sample of blood and observe components. f) Obtain samples of electrocardiograms. Discuss cardiac problems, their prevention and treatment. (If possible, invite speakers from the community.) g) Invite local chapter of American Red Cross to describe value of blood donations and use of components of blood. h) Discuss various blood defects such as hemophilia, leukemia. i) Discuss consequences of antigen-antibody reactions in transfusions, pregnancy, organ transplants. j) Demonstrate coagulation and determination of clotting time. k) Obtain blood with platelets and demonstrate difference in clotting time to normal. l) Demonstrate the effects of various factors such as calcium carbonate and saline-citrate on clotting time. m) Have students prepare charts showing percentage of blood types in different populations. n) Discuss blood factors other than A, B, and O. o) Demonstrate the effects of various substances such as nicotine, caffeine or adrenalin on the heart rate of a daphnia.	Blood Bank Worker/1 Cardiologist/6-8 Electrocardiograph Technician/1-3 Embalmer/4 Hematologist/4-6 Immunologist/6-8 Medical Lab Technician/1-4 Operating Room Technician/1-3 Paramedic /1-2 Physiologist/6-8 Practical Nurse/1-2 Registered Nurse/ 2-4 Vascular Surgeon/ 6-8	Performs routine tests on blood and draws blood samples. Specializes in problems of heart functions. Assists in diagnosing by administering electrocardiogram tests. Preserves bodies. Studies the components of blood. Specializes in reactions of body to foreign substances. Performs tests and assists in medical procedures. Prepares and assists at operating room procedures. Administers emergency aid to ambulance patients. Diagnoses problems of functions. Performs research concerning body systems functioning. Performs technical procedures to assist physician. Assists a physician in hospital or private case. Specializes in blood vessel surgery.

SUGGESTED LABORATORY TOPICS	SUGGESTIONS FOR DEMONSTRATIONS AND MOTIVATIONAL TECHNIQUES	CAREERS

(3) Human Respiration [III, B, 1, 2; p. 59-61]

Objective -
The students should be able to identify the organs of the respiratory system and their positions.

Suggested Approach -
Dissection of vertebrate animal.

Objective -
The students should know some factors which influence the role of breathing.

Suggested Approaches -

a) Determine role of breathing before and after the following situations and graph the results in each case.
   1) varying periods of exercise;
   2) breathing deeply and vigorously with mouth open for one and a half to two minutes; and
   3) breathing deeply and vigorously into a paper bag for two minutes.
b) Determine the time one can hold one's breath after each of the previous three situations.

Objective -
The students should be able to measure lung capacities.

Suggested Approaches -

a) The students exhale into a balloon and measure its diameter, converting this into various lung capacities.
b) If spirometer is available, utilize to measure respiratory volumes and capacities.

(3) Human Respiration

a) A model of the human torso can be used to demonstrate the anatomical positions of the respiratory organs.

b) A bell jar-rubber balloon model of the lungs can be used to demonstrate the role of air pressure in inflating the lungs.

c) A preserved or fresh sheep or cow pluck can be shown or dissected. The pluck usually has the trachea, heart, lungs, and diaphragm. Sometimes these organs are incomplete, but their anatomical arrangement is still apparent.

d) Construct a model of an alveolus using a small inflated balloon and a piece of twine. Color twine half red, half blue, unravel twine in middle, place around balloon and tape.

e) Compare the levels of oxygen and carbon dioxide in inhaled vs. exhaled air.

f) Discuss various diseases of the respiratory system such as emphysema, lung cancer, and some of the factors contributing to the development of these conditions.

g) Discuss the "bends."

h) Refer to section listed under respiration, Unit II, for other applicable demonstrations.

(3) Human Respiration

Career/Education Years	Subject Area
Anesthesiologist/10	Doctor who administers anesthetics and drugs during surgery.
Exercise Physiologist/4-8	Studies relationships of exercise to body physiology.
Respiratory Therapist/1-2	Treats symptoms of people with respiratory disorders such as emphysema.

(4) Human Excretion [IV, A; p. 62-63]

Objective -
The students should be able to name and describe the function of the organs of the human excretory system.

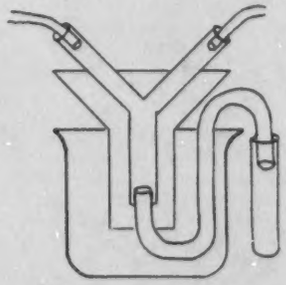
(4) Human Excretion

a) The human torso model can be used to identify and locate the organs of the excretory system.

(4) Human Excretion

Career/Education Years	Subject Area
Biochemist/6-8	Researches chemical processes and products of the body.

SUGGESTED LABORATORY TOPICS	SUGGESTIONS FOR DEMONSTRATIONS AND MOTIVATIONAL TECHNIQUES	CAREERS	
Suggested Approaches -	b) The use of the kidney dialysis machine could be presented or assigned as an out-of-class research project.	Biomedical Engineer/ 6-8	Research into chemical processes and products of the body.
a) Dissect a preserved vertebrate animal. b) Determine the amount of CO_2 exhaled under different circumstances such as rest, mild and strenuous exercise by means of bromthymol blue or phenophthalein. c) Determine the evaporation rates of different liquids from the skin and relate to the role of skin in temperature regulation and excretion. d) Perform urinalysis. Examine centrifuged urine microscopically to identify some solids. Perform simple tests for pH, sugar, salt, and protein. e) Dissect mammalian kidney, observe gross anatomy and examine tissue microscopically.	c) Articles on kidney transplants can be collected and displayed. d) A model of the skin could be used to point out the functions of each layer and the role of the skin as an organ of excretion. e) Construct a model of a nephron consisting of a piece of Y tubing inserted in a large funnel. Connect dialysis tubing to one end of Y tube and place in a beaker of water containing Lugol's solution. Run the tubing back up through the beaker and allow to empty into test tube. Circulate a solution of sugar and starch through plastic tubing attached to other arms of Y tube. Test water in beaker and test tube for presence of sugar and starch and observe contents of dialysis tubing.	Medical Technician/ 2 Pathologist/6-8 Urologist/6-8	Performs batteries of tests of urine samples. Identifies diseased tissue. Specializes in problems of the urinary system.



(5) Regulation [V, A, B; p. 64-67]	(5) Regulation	(5) Regulation	
Objective - The students should be familiar with the structure and function of the mammalian nervous system.	a) Bring in neck of chicken and show spinal cord and protection by vertebrae.	Career/Education Years Audiologist/4	Subject Area Examines for hearing problems.

SUGGESTED LABORATORY TOPICS	SUGGESTIONS FOR DEMONSTRATIONS AND MOTIVATIONAL TECHNIQUES	CAREERS

Suggested Approaches -

a) Dissect brain of cow or sheep. (fresh or preserved).
b) Observe slides of neurons.
c) Dissect a sheep or cow eye.
d) Test for various locations of chemoreceptors in tongue.
e) Test different areas of the skin for varying degrees of sensitivity to touch and temperature.
f) Perform a series of exercises in sensory perception.

Objective -
The students should observe that hormones play a role in regulating life activities.

Suggested Approaches -

a) Stimulate metamorphasis in tadpoles by adding varying amounts of thyroxin to water. Graph the results.
b) Compare heartbeat of daphnia under the influence of varying concentrations of adrenalin in water.

b) Use model of brain to show parts.

c) Demonstrate some human reflexes such as pupil blinking and knee jerk.

d) Discuss diseases of the nervous system such as meningitis, polio, rabies, multiple sclerosis, encephalitis.

e) Demonstrate habits and conditioning. Example: fish feeding.

f) Show photographs (overheads) of people suffering from endocrine malfunction.

g) Induce ovulation in frogs by injecting pituitary hormone.

h) Relate results in pregnancy to hormonal change.

Endocrinologist/ 8-10	Analyzes and treats endocrine problems.
Learning Disability Teacher/4-6	Diagnoses and instructs students with learning problems.
Neurologist/8-10	Diagnoses and treats nerve disorders.
Opthamalogist/8-10	Diagnoses eye disorders.
Optician/2-4	Fits and prepares optical lenses.
Optometrist/5-6	Measures vision; prescribes corrective lenses.
Orthoptist/2-4	Teaches corrective eye exercises to cross-eyed patients.
Pharmacist/5-8	Prepares drugs to treat diseases.

(6) Human Locomotion [VI, A; p. 69-71]

Objective -
The students should observe the gross anatomy of bones.

Suggested Approaches -

a) Observe membranes on exterior of bones. Use cross section of bone to observe blood vessels, marrow, etc.
b) Compare structure of bones of a cat to those of a chicken.

Objective -
The students should observe the microscopic structure of bones.

Suggested Approach -
Utilize prepared slides of bone cells to observe structures such as Haversian Canal.

(6) Human Locomotion

a) Compare several different vertebrate skeletons to demonstrate similarities and differences.

b) Obtain articulated joint from butcher and demonstrate.

c) Demonstrate the bone structure of man and types of joints using a human skeleton.

d) Discuss (or use charts) the importance of proper nutrition for bone growth.

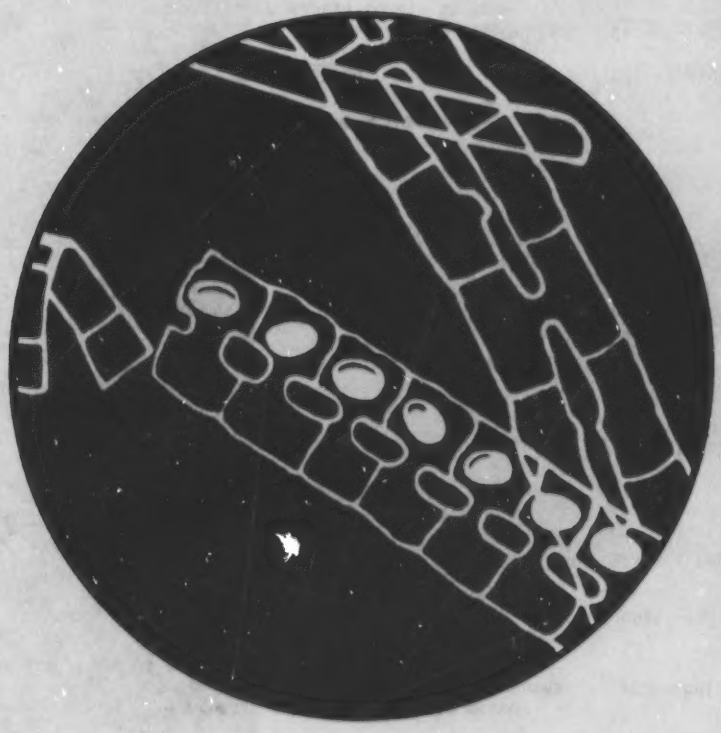
e) Demonstrate joints, cartilage, ligaments in uncooked chicken wings. Point out homologous structures with other skeletons.

(6) Human Locomotion

Career/Education Years	Subject Area
Athlete (Professional)/0-4	Competes on teams or individually.
Coach-Trainer/0-5	Trains athletes.
Chiropractor/2-4	Uses manipulations of muscles and bones to relieve chronic aches.
Orthopedic Surgeon/8-12	Repairs broken bones. Performs corrective surgery for deformities.
Podiatrist/4	Diagnoses, cares for, and prescribes corrective devices for foot ailments.

SUGGESTED LABORATORY TOPICS	SUGGESTIONS FOR DEMONSTRATIONS AND MOTIVATIONAL TECHNIQUES	CAREERS	
Objective - The students should be able to observe the chemical composition of bones. Suggested Approach - Soak bones in 3% HNO_3 to decalcify and bake to remove organic material. (NOTE: inform students of safety procedures when handling acids.) Objective - The students should observe the three types of muscle tissue. Suggested Approach - View prepared slides of skeletal, smooth, and cardiac muscle, noting similarities and differences.	f) Show x-rays of fractures, dislocations, etc. g) Relate the function of bone joint to familiar simple lever systems through use of models. h) Obtain a sample of skeletal muscle (meat), e.g., a heart, an intestine, or stomach, to illustrate the different types of muscles and locations. i) Discuss various diseases of skeletal and muscular systems such as arthritis, rheumatism, muscular dystrophy, and rickets.	Podiatrist/4 Recreation Supervisor/0-4	Diagnoses, cares for, and prescribes corrective devices for foot ailments. Organizes and supervises community or private recreation programs.

Unit IV - Reproduction and Development



Unit IV-- Reproduction and Development

SUGGESTED LABORATORY TOPICS

(1) Mitosis [I, A, 1, 2; p. 74-75]

Objective -
The students should observe and identify the stages of mitosis in plant and animal tissue.

Suggested Approaches -

a) Observe prepared slides of onion root tip, whitefish blastula, or ascaris eggs.
b) Make squash preparations of onion or scallion root tips.

SUGGESTIONS FOR DEMONSTRATIONS AND MOTIVATIONAL TECHNIQUES

(1) Mitosis

a) Use charts, models, overhead projections to illustrate the process.

b) Have students do projects on cancer research.

c) The process of mitosis may be demonstrated by making models of chromosomes from sheets of colored acetate and using them on the overhead projector or flannel board.

d) Models can also be made from pop beads and pipe cleaners.

e) Use thread to demonstrate coiling of chromatin to form chromosomes.

CAREERS

(1) Mitosis

Career/Education Years	Subject Area
Cytologist/4-6	Studies normal and abnormal cells for the detection and diagnosis of disease.
Cytotechnician/2	Prepares slides for micro-examination.
Geneticist/4-8	Studies transmission of characteristics.
Genetic Counselor/ 5-8	Prepares karyotypes and counsels patients concerning possible birth defects.
Medical Lab Technician/2-4	Identifies cells in research, hospital, industrial, and pharmaceutical laboratories.
Molecular Biologist/4-8	Investigates changes occurring at molecular levels during mitosis.
Teaching/4-8	Relates information concerning normal and abnormal cells division in schools, hospitals, and community organizations.

(2) Asexual Reproduction [I, B, 1-5; p. 76-77]

Objective -
The students will observe asexual reproduction in representative organisms and note their similarities and differences.

Suggested Approaches -

a) Observe fission in living protists or prepared slides of protists.
b) Observe yeast and hydra undergoing budding.
c) Observe sporulation in bread mold, mushrooms, or ferns.

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(2) Asexual Reproduction

a) Prepare petri dish with agar, sprinkle with soil or expose to air to show prevalence of mold spores in an environment.

b) A mock-up of sporulation can be produced using a block of clay (bread), a pencil (hyphae) and balloon (sporangium) filled with paper balls or tiny foam beads (spores). Bursting balloon represents sporulation.

(2) Asexual Reproduction

Career/Education Years	Subject Area
Microbiologist/4-8	Investigates the growth and character of microscopic organisms such as bacteria, viruses, and molds in public health, private industry, and research hospitals.
Microbiology Technician/2	Prepares materials for examination.

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SUGGESTED LABORATORY TOPICS	SUGGESTIONS FOR DEMONSTRATIONS AND MOTIVATIONAL TECHNIQUES	CAREERS
d) Perform regeneration experiment with hydra and planaria. e) Have students propagate plants by vegetative means such as: cuttings, runners, bulbs, tubers, etc.	c) Discuss the commercial importance of regeneration in starfish and lobster. d) Demonstrate grafting using a tomato stem and potato stem.	Mycologist/4-8 — Tests food and water supplies; oversees drug manufacture.

(3) Sexual Reproduction
[II, A, 1, 2, 3; p. 77-82]

Objective -
The students should be able to demonstrate the major events occurring during meiosis and the end results.

Suggested Approaches -

a) Observe cells undergoing meiosis in the anthers of tradescantia.
b) Observe prepared slides of sperm of representative animals.
c) Remove testes of live grasshopper. Observe spermatocytes in various stages of development.

Objective -
The students should be able to identify the parts of the reproductive systems of a variety of animals.

Suggested Approach -
Dissection of organisms, such as the earthworm.

Objective -
The students should observe developmental stages of selected animals.

Suggested Approaches -

a) Observe prepared slides or microviewer slides of starfish and/or sea urchin development.
b) Observe the fertilization and development in frog eggs.
c) Incubate fertile chicken eggs. Observe the development.

(3) Sexual Reproduction

a) Illustrate the main chromosomal changes occurring during meiosis by means of pop beads, pipe cleaners, or colored chalk.

b) Show unequal cytoplasm division in meiosis by squeezing an inflated balloon.

c) Bring in chicken's egg and discuss parts and function.

d) Bring in and compare eggs of fish, amphibians and birds to demonstrate adaptations to different environments.

e) Arrange a trip to a nearby fish hatchery to observe fertilization and development of fish.

f) Demonstrate gastrulation by indenting hollow rubber ball or balloon.

(3) Sexual Reproduction

Career/Education Years	Subject Area
Animal Husbandry Specialist/2-4	Research into the breeding of domestic farm animals.
Artifical Breeding Technician/2	Collects semen from livestock and artificial impregnation of animals.
Beekeeper/on-the-job	Supervises pollination programs and honey production.
Embryologist/5-8	Studies animal development, specifically the causes of normal and abnormal development.
Hatchery Worker/ 2-4	Supervises and maintains fish or poultry hatcheries.
Neonatologist/8-10	The care and treatment of the newborn.
Nurse-Midwife/2-4	Delivers babies under supervision of physician.
Nursery Nurse/2-4	Cares for the newborn.
Obstetrical Nurse/ 2-4	Assists with delivery and patient care.
Obstetrical Aide/ on-the-job	Cares for the newborn.
Obstetrician and Gynecologist/8-10	Treats pregnancies -- deals with the diseases and the hygiene of women.
Pediatrician/8-10	Care and treatment of children.
Social Worker/4-6	Provides counsel and assistance concerning family problems.

SUGGESTED LABORATORY TOPICS

(4) Reproduction and Development in Flowering Plants [II, B, 1-5; p. 86-89]

Objective -
The students should be able to identify the parts of the flower and relate structure to function.

Suggested Approaches -

a) Dissect a flower, identifying the parts.
b) The students may observe temporary or preserved slides of ovaries, anthers, and pollen.
c) The students may observe developing pollen tubes by preparing hanging drop slides with mature pollen in 10% sucrose solution.

Objective -
The students should be able to relate structure of fruit and seed to reproductive function.

Suggested Approaches -

a) Select several types of fruits. (Tomato, pea, bean, and corn.) Dissect to show arrangement and attachment of seeds.
b) Dissect soaked monocot and dicot seeds observing external and internal structures and relate to function.
c) Test endosperm or cotyledon for starch, sugar, protein, and lipids.

Objective -
The students should observe factors affecting seed germination.

Suggested Approach -
Set up seed germination experiments by varying conditions such as moisture, oxygen, temperature, and light intensity.

SUGGESTIONS FOR DEMONSTRATIONS AND MOTIVATIONAL TECHNIQUES

(4) Reproduction and Development in Flowering Plants

a) Display various types of flowers relating variation in structure to differences in pollination and fertilization.

b) Mount various types of pollen grains for miscroscopic observation.

c) Display various types of fruits and seeds, relating differences to variations in methods of seed dispersal.

d) Have students observe various twigs, noting the buds.

e) Demonstrate differential in growth over period of time by removing the apical meristem of several plants such as coleus and comparing with normal.

f) Have students observe slides of longitudinal sections of coleus meristem.

g) Demonstrate the variety of changes that occur during seed germination such as:
1) CO_2 released
2) change of volume
3) O_2 consumed
4) production of heat
5) digestion of starch

CAREERS

(4) Reproduction and Development in Flowering Plants

Career/Education Years	Subject Area
Agronomist/6	Experiments with field crop problems and develops new methods of growing crops to make farming more efficient.
Botanist/4-8	Agricultural research and maintains farms, teaches, plans botanical gardens; florist.
Farmer/on-the-job	Selects and breeds crop plants.
Florist/on-the-job	Grows and cares for plants as a commercial enterprise.
Horticulturist/2-8	Maintains plants in botanical gardens, working with orchard and garden plants to improve plant culture.
Seed Analyst/2-4	Conducts tests and experiments with seeds for analysis of germination, growth, and vigor.

Unit V - Transmission of Traits from Generation to Generation

Unit V-- Transmission of Traits from Generation to Generation

SUGGESTED LABORATORY TOPICS

(1) Foundations of Genetics [I, A, B, II, A, B, D; p. 93-96]

Objective -
The students should understand simple laws of probability and how they apply to the transmission of genetic traits.

Suggested Approach -
Have students perform a series of trials in which they randomly toss coins, pick out two colored marbles, beads, or beans, or toss dice. Record results and determine ratios.

Objective -
The students should observe genetic crosses and relate the results to Mendelian principles of heredity.

Suggested Approaches -

a) Dominance: Perform genetic crosses using drosophila, mice or neurospora, utilizing dominant vs. recessive traits. Gather data from F1 and F2.
b) Segregation and Recombination: Set up two containers each containing equal numbers of two different colored marbles (jelly beans, etc.). Choose one from each container and combine. Draw 100 sets, interpret data.
c) Cross wild and mutant strains of the mold sordaria. Observe results.
d) Independent Assortment: Breed drosophila with two varying traits such as normal wings and red eyes vs. vestigial wings and sepia eyes. Breed to F2.

(2) Sex Determination [II, H, I; p. 97]

Objective -
The students should understand how sex is determined and how sex-linked traits are transmitted.

SUGGESTIONS FOR DEMONSTRATIONS AND MOTIVATIONAL TECHNIQUES

(1) Foundations of Genetics

a) Purchase seeds of corn, tobacco, peas, or sorghum that have been bred to demonstrate genetic ratios. Germinate. Observe and relate results to Mendelian principles.

b) Use flannel board and symbols to demonstrate genetic crosses.

c) Use pipe cleaners soaked in weak solution of acid and base to represent dominant and recessive traits. Place various combinations in test tubes containing indicators.

d) Several weeks prior to beginning unit, germinate and grow seeds of sweet peas to show the type of organism with which Mendel experimented.

e) Obtain samples of round and wrinkled peas and constricted and inflated pods to illustrate traits Mendel traced.

f) Show independent assortment by setting up two divided paper plates in which you place two different colored marbles in each half. (Example: blue and green in one half, red and white in the other half.) These represent two pairs of heterozygous genes. Draw one marble from each half of both plates and combine to form gametes.

(2) Sex Determination

a) Soak several pipe cleaners in a solution of pH of 6 (X) and several in a solution of pH of 2-3 and bend (Y). Place either 2X pipe cleaners or an X and a Y in a test tube containing weak congo red solution.

CAREERS

(1) Foundations of Genetics

Career/Education Years	Subject Area
Agronomist (County Extension Agent, Seed Producer, Seed Technologist) / 4	Advises farmers or gardeners on variety of crop related problems.
Animal Husbandry/ 2-4	Scientifically breeds animals.
Farmer/on-the-job	Breeds plants and animals.
Fishery Biologist/4	Research and study of life histories and habits of aquatic organisms for breeding purposes.
Geneticist/5-8	Studies the transmission of genetic traits and abnormalities.
Horticulturist/4	Employs techniques for proper breeding and maintenance of plants.

(2) Sex Determination

Career/Education Years	Subject Area
Animal Husbandry Specialist/2-4	Research into the breeding of domestic farm animals.

SUGGESTED LABORATORY TOPICS	SUGGESTIONS FOR DEMONSTRATIONS AND MOTIVATIONAL TECHNIQUES	CAREERS	
Suggested Approaches a) Cut small blocks of wood (1 cubic inch), paint two different colors to represent Y and X chromosomes. Paint symbols on X blocks to represent genes, example, C, c). Set up on box with X blocks to represent female, one box with X and Y blocks to represent male.(Use any genotype combination desired.) Draw one block from each box, and pair. b) Cross drosophila possessing contrasting sex-linked traits such as red and white eyes or normal and yellow bodies.	b) Prepare transparency with diagram of egg. In center, outline human figure. On overlapping transparencies, diagram two sperm; one pink with picture of girl, one blue with picture of boy. The figures within these sperm should be the same size as in the egg so that when a "sperm" is placed over the "egg," the image is either male or female.	Artificial Breeding Technician/2	Collects semen from livestock and artificially impregnates animals.
		Embryologist/5-8	Studies animal development, specifically the causes of normal and abnormal development.
		Farmer/on-the-job	Selects and breeds crops, plants, and animals.
		Genetic Counselor/ 4-8	Counsels patients on transmission of traits, diagnosis and screening.
		Geneticist/4-8	Studies the transmission of genetic traits.
		Obstetrician and Gynecologist/8-10	Treat pregnancies -- deal with the diseases and the hygiene of women.
		Pediatrician/8-10	Cares for and treats children.
		Social Worker/4-6	Provides counsel and assistance concerning family problems.

(3) Mutations [III, A, B; p. 97-99]

Objective -

The students should observe changes in genes or chromosomes which result in changes in structure or function.

Suggested Approaches -

a) Obtain nutritional mutants and normal strains of either Neurospora, E. Coli, or Sordaria. Culture on minimal and complete media to observe the effects of mutation.
b) Induce polyploidy in the cells of onion root tips by growing roots in colchicine.
c) Have students prepare human karyotypes from photographs of chromosomes in cells with various genetic defects -- prepare normal karyotype as a comparison.

(3) Mutations

a) Construct two chains of pop beads of different colors. Use to demonstrate linkage and crossing over.

b) Obtain free materials from sources such as March of Dimes illustrating various results of mutations and birth defects.

c) Allow irradiated seeds or Drosophila eggs to develop. Observe the frequency of abnormalities in the irradiated group and compare to the frequency in the nonirradiated control.

(3) Mutations

Career/Education Years	Subject Area
Cytogeneticist/4-8	Examines cells and chromosomes to detect abnormalities. Does genetic research on cellular level.
Cytotechnologist/4	Screens human cells to detect abnormalties.
Orchard Manager/1-4	Selects and breeds varieties of plants to insure highest yield.

SUGGESTED LABORATORY TOPICS	SUGGESTIONS FOR DEMONSTRATIONS AND MOTIVATIONAL TECHNIQUES	CAREERS
d) To relate the fact that genes cause biochemical differences resulting in varying physical expression, chromatograph a series of various colored eyes of drosophila. Compare the various pigments.	d) To demonstrate that man has been aware of mutations throughout history, show photographs depicting such cases. e) Point out fact that plant and animal breeders utilize mutants to develop new varieties. Illustrate using specific examples.	
(4) Interaction of Heredity and Environment [V; p. 100] Objective - The students should be able to demonstrate the role of the environment on the expression of certain genes. Suggested Approaches - a) Grow tobacco, tomato, radish, or bean seedlings under conditions in which light is the only variable. b) Grow dandelion plants in conditions of varying atmospheric moisture. Compare the plants. c) Grow plants with variegated leaves in bright sunlight, dim light, and darkness. Compare degrees of variation. d) Culture stocks of drosophila with genes for curly wings under different temperature conditions and compare.	(4) Interaction of Heredity and Environment a) Grow potatoes under conditions of light and dark. Compare growth. b) Discuss development of queen bee in the hive as a result of special feeding. c) Show photographs of identical twins raised under different environmental conditions. d) Demonstrate the concept of a gene being present but not expressed unless conditions in environment are appropriate by: - Filling test tube half full of water. - Add phenolphthalein -- gene. - Solution remains clear -- gene not expressed. - Add base -- change of environment. - Color change -- gene expressed.	(4) Interaction of Heredity and Environment Career/Education Years — Subject Area Entomologist/4 — Performs research to control insects affecting crops, man, and animals. (biological control.) Forestry/4 — Manages organisms in forests.
(5) Human Heredity [VI; p. 100-101] Objective - The students should be familiar with several human genetic traits and be able to trace and predict their transmission. Suggested Approach - Choose one or more human genetic traits such as tongue rolling, taste test papers, hitch hikers thumb, widowspeak, attached ear lobes, blood types, and determine the mode of transmission. 1) Have student poll a sample of a given population in school or community.	(5) Human Heredity a) Illustrate large pedigree chart such as that of the Royal families of Europe (Queen Victoria). b) Illustrate fact that pedigree charts are used for other organisms besides humans -- examples, dogs, horses, etc. If students have registered dogs, have them bring in pedigree. c) If a hospital nearby has genetic counseling centers, investigate possibility of guest speaker.	(5) Human Heredity Career/Education Years — Subject Area Corrective Therapist/5 — Treats patients by medically prescribed physical exercise and activities. Dietician/4-6 — Manages food service, plans special menus, gives instruction. Diagnostic Medical Sonographer/1-2 — Uses high frequency sound waves assisting physicians in diagnostic work.

SUGGESTED LABORATORY TOPICS	SUGGESTIONS FOR DEMONSTRATIONS AND MOTIVATIONAL TECHNIQUES	CAREERS	
2) Trace a particular trait or traits in his/her family and develup a pedigree chart.		Genetic Counselor/5-8	Counsels patients on transmission of traits; diagnosis, screening.
		Nurse Practitioner/ 4-5	Maintains own case load of patients, provides care and support.
		Occupational Therapist (Rehabilitation Therapist/4-5	Aids in treatment of physical, emotional, or developmental difficulties.
		Physical Therapist/4	Plans, conducts, and evaluates programs to assist patients in increasing strength, endurance, and use of assistive devices.
		Social Worker/4-5	Works with genetic counseling team in total patient care program.
		Therapist(Recreational)/4-6	Assists patients in adjusting to defects through specially designed recreational activities.

(6) Nucleic Acids [VII, A, 1; p. 102-104]

Objective -

The students should understand that nucleic acids are large, organic molecules present in specific parts of the cell and contain the coded information which determines the characteristics of the cell or organism.

Suggested Approaches -

a) Stain cells (cheek, onion, etc.) with a DNA specific stain such as acetocarmine or acetoorcein, to show presence of DNA.
b) Extract DNA from cauliflower or E. Coli (see lab manuals).

(6) Nucleic Acids

a) Purchase or construct model kits depicting structure of DNA molecule.

b) Prepare salivary gland squash of drosophila, and point out stained chromosomes.

c) Construct components of DNA and RNA molecules from molecule building kits to illustrate concepts of size and complexity.

d) Demonstrate protein synthesis by preparing:
M-RNA - chain of paper containing codons.
t-RNA - small cards with anticodons and instructions to pick up a specific amino acid.
amino acid - cards with name of one amino acid.
Pass t-RNA cards to students, have them act as t-RNA molecules and pick up the amino acids as the M-RNA is decoded.

(6) Nucleic Acids

Career/Education Years	Subject Area
Biochemist/4-8	Studies chemical composition and behavior of living organisms.
Microbial Geneticist/ 4-9	Uses mutant micro-organisms to produce antibodies, hormones, research in recombinant DNA.
Nuclear Medicine Technologist/2-3	Uses radioactive materials to study or cause mutations.

Unit VI - Evolution

Unit VI– Evolution

CREATIONISM AND EVOLUTION

There are several views regarding origins and changes that have occurred on the Earth over time. Six-day creation, gap creation, progressive creation, theistic evolution, creationism, evolution, and planetary seeding are terms used to describe some of these views. The contrasts among these ideas, especially between creationism and evolution, have been widely discussed.

During the process of revising the Regents Biology Syllabus, suggestions for including creationism as part of this course of study were forwarded to the New York State Education Department. It was suggested that the topic Modern Evolution be replaced by a two-model approach involving creationism and evolution.

The State Education Department requested expert scientific examination of this suggestion in terms of its bases in modern science and its appropriateness for the State high school biology curriculum. The American Association for the Advancement of Science, the American Institute for Biological Sciences, the National Association of Biology Teachers, and the New York Academy of Sciences reviewed the creationism materials and made recommendations as to their inclusion in the science curriculum. Department staff members met with representatives from these scientific associations to review their expert opinion concerning the use of creationism materials in high school science courses.

Their opinion was that creationism does not qualify as information generated by scientific processes and is not part of the body of scientific knowledge accepted by most scientists. Also expressed was the view that creationism can neither be verified nor refuted through scientific investigation and that models or theories which involve the supernatural are not within the domain of science. Accordingly, the following are recommended:

1. Contrasting religion with scientific theories is not the role of the science teacher. Students should be informed, however, that there are supernatural accounts of origins outside the domain of science. These accounts are derived mainly from scripture and religious authority and are beyond the scope of scientific investigation. The personal religious beliefs of an individual are safeguarded by the Constitution, and should be respected.

2. It should be understood that "scientific creationism" is not accepted as science by the majority of experts working in those fields of science related to origins. It is considered by these experts to be a field of study more closely related to religion than to science.

3. Evolution should be taught, not as a fact, but as a scientific theory which has substantial support from the scientific community. The concept of modern evolution incorporates the work of many scientists. Current dialogues among scientists are indicative of possible modifications in evolutionary theory.

4. Teachers should respect the personal beliefs of students and recognize that in a pluralistic society, the personal beliefs of some may not be compatible with all aspects of evolutionary theory.

The teaching of the supernatural accounts of origins by science teachers in science classrooms as part of the science curriculum is not a recommended procedure. Science teachers should acknowledge the personal validity of their students' beliefs and direct the students to the most appropriate counsel for assistance in questions outside the scope of the science classroom. Technical questions beyond the training and background of the science teacher about the fossil record, homology, biochemistry, etc., should be directed to specialists in those fields. Questions related to scripture, revelation, and the supernatural should be directed to the religious authorities on those topics.

(1) Evolution Theory - Supporting Observation
[II, A; p. 108-110]

Objective -
The students should be able to make generalizations about possible similarities of relationships and ancestry.

(1) Evolution Theory - Supporting Observation

a) Prepare or demonstrate a geologic time chart.

b) Display and use a Geiger counter and discuss the use of related instruments in radioactive dating.

c) Simulate preservation in amber by preparing or displaying specimens preserved in transparent plastic.

(1) Evolution Theory - Supporting Observation

Career/Education Years	Subject Area
Archaeologist/4-8	Researches and studies primitive sites of human habitation.
Biochemist/4-8	Research and study; analyzes chemical components of living things.

SUGGESTED LABORATORY TOPICS	SUGGESTIONS FOR DEMONSTRATIONS AND MOTIVATIONAL TECHNIQUES	CAREERS

Suggested Approaches -

a) Examine and compare a variety of fossils, determine the type of fossil (imprint, amber, etc.) taxonomic placement, position in relationship to other organisms in the geological time chart.
b) Examine skeletons of various vertebrate animals and compare the numbers, structure, and arrangement of joints and bones.
c) Analyze biochemical similarities and differences determined from chromatographic separation of pigments in various plants or from immunological kits containing artificial blood sera.
d) Compare the embryonic development of a series of vertebrates by examining preserved specimens.
e) Utilizing the data in one or more of the approaches (a) through (d), have students develop possible explanations for differences and similarities among various life forms.

d) Produce simulated fossil imprints in Plaster of Paris or ice.

e) Show pictures of rock strata from a region such as the Grand Canyon, and relate to sedimentation and fossil formation.

f) Display petrified wood.

g) Field trips to museums where displays of fossils and natural history are available.

Career/Education Years	Subject Area
Geologist/4-8	Directs excavations, interprets finds.
Microbial Paleontologist	Studies fossil microorganisms to detect possible oil deposits; does research in evolution.
Museum Curator/4	Prepares displays.
Paleontologist/4-8	Studies fossil finds.
Taxidermist/on-the-job	Mounts skeletons and skins; does artistic restorations.

(2) Theories of Evolution [II, B; p. 110-111]

Objective -

The students should be able to observe and test some of the explanations which attempt to account for the diversity of organisms.

Suggested Approaches -

a) To observe the variation that exists within a population, measure the length of seeds, leaves of plants, shells of mollusks, diameter of wrists, percentages of germination, or any other such factors. Tabulate and graph results. Relate concepts of variation and transmission of traits to the possible appearance of new species.

(2) Theories of Evolution

a) Discuss evolution of a characteristic, such as the long neck of the giraffe, according to several theories such as those of Lamarck, Darwin, and DeVries.

b) Discuss examples of situations that support Weismann's theory and dispute Lamarck's theory:
   1) Breeds of dogs with tails or ears clipped.
   2) Circumcision in groups of humans over thousands of years.
   3) Enlarged human lips produced by inserting discs (in certain tribes).
   4) Appearance of an elongated neck by adding rings (in reality due to lowering of thoracic cage).
   5) Binding of feet in some oriental cultures.

c) Observe specimens of various phyla to illustrate variations.

(2) Theories of Evolution

Career/Education Years	Subject Area
Demographer/6-8	Gathers and interprets statistical data regarding human populations.
Field Biologist/4-8	Gathers specimens and data from on-site locations.
Geneticist/4-8	Carries out research dealing with the transmission of hereditary traits.
Library Research; Science Specialty/4-8	Gathers records and other information regarding the work of scientists.
Microbiologist/6-8	Laboratory research dealing with microscopic organisms and cells.

SUGGESTED LABORATORY TOPICS	SUGGESTIONS FOR DEMONSTRATIONS AND MOTIVATIONAL TECHNIQUES	CAREERS
b) Overpopulation - Students should plant varying numbers of seeds, such as 10-100 in increments of 10, in separate pots of the same size and maintain them under identical conditions. After germination, count and graph the percentages of survivors. Compare the characteristics of survivors in each group.	d) Discuss overproduction and survival rate by using examples such as dandelion, milkweed, or fish. e) Display pictures of varieties of organisms developed by humans through selection. Discuss the inference that humans, by artificial selection, simulate, in a greatly reduced time, what may happen in nature over much longer periods.	
(3) Modern Evolutionary Theory [II, B, 3; p. 111-113] Objective - The students should observe and be able to relate some of the factors that are operational in an evolutionary system. Suggested Approaches - a) Have the students observe differences in sensitivity of different species of bacteria to various antibiotics and infer how resistant strains may develop. Relate these observations to the continued need to develop new antibiotics. b) To observe the selective forces of the environment on specific traits, have students prepare and then scatter a number of varied, colored paper discs. (Choose one color which blends with environment and one which contrasts.) Collect the discs after scattering and tabulate the percentage of each color recovered.	(3) Modern Evolutionary Theory a) Discuss the relationship between sickle-cell anemia and resistance to malaria. b) Discuss possible mechanisms for isolation, such as movements (plate tectonics theory). c) Display pictures or examples of changes in population frequency, such as the peppered moth, and discuss possible causes. d) By means of pictures, illustrate changes produced by breeders, such as primitive vs. hybrid corn, long-horn cattle vs. beef cattle, wild boars vs. pigs. e) Refer back to unit on DNA and mutations to discuss possible mechanisms of genetic change.	(3) Modern Evolutionary Theory Career/Education Years — Subject Area Bacteriologist/4-8 — Cultures and studies bacteria to gather new information regarding the metabolism, physiology, and survival adaptations of these organisms. Entomologist/4-8 — Studies insects. Population Geneticist/6-8 — Studies population shifts (changes occurring in populations of living organisms). Pharmaceutical Research/6-8 — Researches mutations that occur in micro-organisms and the development of drugs to combat these mutations.
(4) Heterotroph Hypothesis [III,A,B,C; p.114-115] Objective - The students should be able to relate the formation of coacervates in the laboratory to one possible hypothesis for the origin of life on earth.	(4) Heterotroph Hypothesis a) Use a Tesla coil, radiometer, and radioactive source with detector to illustrate energy sources available on the primitive earth.	(4) Heterotroph Hypothesis Career/Education Years — Subject Area See (1) through (3).

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SUGGESTED LABORATORY TOPICS	SUGGESTIONS FOR DEMONSTRATIONS AND MOTIVATIONAL TECHNIQUES	CAREERS

Suggested Approach -

Prepare a coacervate and observe the formation of discrete aggregates. This can be done from a purchased kit or by adding 5 ml of gelatin and 3 ml of gum arabic to distilled water. Place in test tube, add 0.1 ml HCl drop by drop and stir until cloudy. Place on slide and observe under microscope.

b) Display pictures of heterotrophic and autotrophic protists, comparing them and relating them to the possible development of life forms according to the heterotroph hypothesis.

Unit VII - Ecology

Unit VII-- Ecology

SUGGESTED LABORATORY TOPICS

(1) Abiotic Factors [III, A, 1, a; p. 119]

Objective -
The students should be aware of the abiotic factors in an environment and their role in determining the biotic community.

Suggested Approaches -

Measurement of Abiotic Conditions:

a) Water -- Collect sample of water from pond, stream, lake, river, marsh, ocean, or aquarium. Determine the following:
   1) temperature
   2) pH
   3) total dissolved solids
   4) total suspended solids
   5) oxygen
   6) carbon dioxide
   7) nitrates/nitrites
   8) phosphates

b) Soil -- obtain sample of soil from forest, lawn, vacant lot, etc., and test for:
   1) pH
   2) temperature
   3) porosity
   4) nutrient level: phosphorus, potassium, nitrogen.

c) Atmosphere -- Select a particular site such as forest, meadow, vacant lot, or city street and determine the following conditions:
   1) temperature of air and ground surface
   2) relative humidity
   3) light intensity at different levels.

(2) Biotic Factors and Organization [III, A, 1, b; p. 120-121]

Objective -
The students should understand the various levels of biotic organization in the biosphere.

SUGGESTIONS FOR DEMONSTRATIONS AND MOTIVATIONAL TECHNIQUES

(1) Abiotic Factors

a) Bring in a bag of commercial fertilizer and relate contents to mineral needs of plants. Discuss necessity of repeated application.

b) Set up and contrast two "gold fish bowls" or aquaria, one with no filter or aerator and one containing one or both, to illustrate importance of dissolved oxygen in water.

c) Display several small organisms and have students list conditions necessary for their survival.

d) Place small fish in container of water. Measure change in oxygen content by titration over half-hour period.

e) Discuss the availability of light at various depths in the ocean. Relate to life forms at various levels.

(2) Biotic Factors and Organization

a) Construct miniature ecosystems in small jar, terrarium, or aquarium

b) Use a Berlese funnel or Tullgren funnel to extract arthropods from a sample of soil. Identify, classify, and count the organisms.

CAREERS

(1) Abiotic Factors

Career/Education Years	Subject Area
Chemist and Chemical Engineer/4-7	Studies composition and properties of substances and their reactions.
Forestry Aide/1-2	Collects and reads data, monitors instruments, stream flow, rain gauge, and road surveys.
Geologist and Geological Engineer/ 4-7	Studies structure, composition, and history of Earth's crust. Conducts oil and gas explorations.
Meterologist/5	Studies changes in earth's atmosphere.
Physical Scientist/ 4-8	Tests natural resources. Observes environmental changes.

(2) Biotic Factors and Organization

Career/Education Years	Subject Area
Aquatic Biologist/4-7	Studies the interactions of plants and animals in water.

SUGGESTED LABORATORY TOPICS	SUGGESTIONS FOR DEMONSTRATIONS AND MOTIVATIONAL TECHNIQUES	CAREERS

Suggested Approaches -

a) Use the sampling technique to determine the species diversity in a natural community such as a lawn, woodlot, pond, marsh, etc.
b) Select a site around the school grounds. Map and record the location and density of living organisms on the population, community, or ecosystem level.
c) Observe a sample of pond or ocean water. Determine the diversity and density of the various micro-organisms.

c) Set up ant farm to illustrate a population in a community.

Botanist/4-8

Morphologist/4-8

Botanical Pathologist/4-8

These careers involve the study of the relationship between plants, their environment, and their structure, and of plant diseases.

(3) Energy-Flow Relationships
[III, A, 2; p. 121-123]

Objective -

The students should be able to describe the nutritional interactions among organisms in an ecosystem.

Suggested Approaches -

a) Examine and identify organisms in a decaying log and classify them according to their nutritional relationships.
b) Examine a piece of log or rock containing lichens. Crush lichen and observe algal and fungal cells under microscope.
c) Examine the gut contents of a freshly killed insect, fish, crustacean, or other available organism. Identify the food particles and any parasites in the digestive tract.
d) Observe an operational food chain over a period of time by setting up a culture of chlorella, paramecium, blepherisma and daphnia. Take random samplings of the culture and determine relative numbers (density) of each type of organism at the start and at prescribed intervals thereafter. Data can be used to construct a food pyramid.
e) Prepare wet mount of crushed nodule from root of a legume. Stain and observe.

(3) Energy-Flow Relationships

a) Point out organisms in an aquarium existing in symbiotic relationships.

b) Refer back to Unit VI Evolution, suggested lab #2b, overpopulation, and discuss data observed relating it to competition in an ecosystem.

c) Prepare and discuss a graph of competition curves demonstrating the results of mixing cultures of Paramecium aurelia and P. caudatum.

d) Select a variety of different ecosystems, have students prepare charts illustrating the organisms and their food relationships.

e) Have students represent specific organisms in an ecosystem. Use string to show food chains that might exist.

f) Grow earthworms in box of soil to demonstrate their role as decomposers and their importance in garden or farm.

g) Discuss, or take field trip to a nearby sewage treatment plant to illustrate the role of bacteria.

(3) Energy-Flow Relationships

Career/Education Years	Subject Area
Entomologist/4-7	Studies the relationship between insects and other forms of life.
Parasitologist/4-8	Studies parasitic relationships.
Range Manager/4	Cares for and maintains rangelands. Conserves wildlife habitats. Works with local ranchers who graze livestock.
Toxicologist/4	Studies poison substances and their effects on living things.

SUGGESTED LABORATORY TOPICS	SUGGESTIONS FOR DEMONSTRATIONS AND MOTIVATIONAL TECHNIQUES	CAREERS
	h) Illustrate the concept of biomass or an energy pyramid by placing wooden stakes in ground in the form of a pyramid (several levels) and connect with string. Have as many students as possible stand in the various levels. Discuss the fact that fewer numbers are present in upper levels. i) To illustrate the concept of a biomass pyramid, point out that in countries having less land area for food production, people must depend primarily on plants for food rather than developing animal food sources.	
(4) Material Cycles [III, A, 3; p. 123] Objective - The students should understand the necessity of the recycling of materials in the biosphere. Suggested Approach - To study the carbon dioxide - oxygen cycle, place water and bromthymol blue in four test tubes. To tube 1, add nothing and cap. To tube 2, add snail and cap. To tube 3, add elodea and cap. And to tube 4, add elodea and snail and cap. Place in bright light for 24 hours and observe.	(4) Material Cycles a) Demonstrate the water cycle by setting up an apparatus showing the evaporation and condensation of water. Note: begin with muddy or colored water. b) Prepare charts illustrating cycles such as nitrogen, calcium, etc. c) Prepare ahead to demonstrate the importance of nitrogen-fixing bacteria in the nitrogen cycle. Set up four pots of clover seeds under identical conditions. Add purchased cultures of nitrogen-fixing bacteria to two. Compare growth and relate the concept of crop rotation.	(4) Material Cycles Career/Education Years — Subject Area Agronomist/4-8 — Studies the interaction of crop production and soil management. Agricultural Engineer/4-7 — Plans, designs, and constructs machinery for agricultural use. Farmer/0-4 — Employs knowledge of mineral cycles to assure high crop productivity. Soil Conservationist/4-6 — Studies, plans, and implements ways to improve soil quality, use, and productivity.
(5) Ecosystem Formation Succession [III, B, 1; p. 124-125] Objective - The students should be able to explain how succession results from the interaction of organisms and the environment.	(5) Ecosystem Formation Succession a) Study communities in various stages of succession in areas such as forest, marshes, beaches, meadows, vacant lots, and rocky areas.	(5) Ecosystem Formation Succession Career/Education Years — Subject Area Game Warden/1-4 — Works in parks or preserves with monitoring of animals.

SUGGESTED LABORATORY TOPICS	SUGGESTIONS FOR DEMONSTRATIONS AND MOTIVATIONAL TECHNIQUES	CAREERS

Suggested Approaches -

a) Study several logs in various stages of decay. Identify the organisms in the logs. Note the results of their activities and the ways in which they relate to each other.
b) Set up a hay infusion or samples of pond water and observe succession over a period of several weeks.

b) (Long Term). Take photographs over a period of years of a familiar local area in which you observe succession occurring. Set up a display.

c) Compare bare rocks to those containing lichens. Note the effect of the lichens on fragility of rocks.

Range Manager/4	Insures proper utilization of rangelands.

(6) Biomes [III, B, 3; p. 126-130]

Objective -
The students should be aware of some of the various conditions that contribute to the development of particular biomes.

Suggested Approach -
Make field trips to one or more local areas and indicate the type of biome. Observe and record the abiotic and biotic factors that determine the particular characteristics of the biome.

(6) Biomes

a) Compare temperatures and precipitation data from various localities and make a climatogram.

b) Prepare charts and bulletin board displays depicting various biomes.

c) Using pictures and displays, discuss the adaptations of organisms for survival in the different biomes.

(6) Biomes

Career/Education Years	Subject Area
Aquaculturist/2-6	Measures and studies conditions for raising aquatic organisms.
Forestry Aide/1-2	See previous listing.
Marine Biologist/4-8	Studies living forms in the ocean.
Oceanographer/4-7	Studies ocean currents and movements.
Oceanographic Technician/2	Measures various physical and biotic factors in oceans.
Park Ranger/4	Studies and monitors organisms and conditions in parks. Instructs the public.
Wildlife Attendant/0	Works in parks, hatcheries, refuges and animal conservation areas.

(7) Biosphere and Humans [IV, A; p. 130-135]

Objective -
The students should be aware of some of the ways humans have affected their environment.

(7) Biosphere and Humans

a) Graph human population vs. time over the last 2,000 years to illustrate the recent rapid growth in human population. Relate to increased rate of pollution, use of natural resources, and problems with supplying food.

(7) Biosphere and Humans

Career/Education Years	Subject Area
Civil, Industrial, and Mechanical Engineers/4-8	Plan, design, construct bridges, roads, waterways, and antipollution devices.

SUGGESTED LABORATORY TOPICS	SUGGESTIONS FOR DEMONSTRATIONS AND MOTIVATIONAL TECHNIQUES	CAREERS	
Suggested Approaches - a) Observe and determine the effects of oil on aquatic organisms. Set up two beakers, each containing water and an aquatic plant. Add oil to one. b) Observe effects of varying concentrations of different water pollutants such as nitrates and phosphorus on aquatic organisms. c) Collect samples of particulate pollutants on microscopic slides covered with vaseline and observe.	b) Display pictures showing air and water pollution. c) Discuss the idea of effects of pesticides on food chains and of increasing concentrations at higher levels. d) Prepare a chart depicting organisms that have become extinct over the last 200 years and some in danger of extinction. Discuss causes. e) Take field trip to local public park, industrial complex, factory or other convenient facility. Observe, record, and discuss the impact on the locale.	Environmental Engineer/4-7	Applies engineering principles to environmental problems.
		Environmental Inspector/2-3	Determines environmental purity and analyzes smoke, water, and waste.
		Incinerator Plant Attendant/0	Supervises waste disposal.
		Noise Control Specialist/2-7	Studies noise sources and their effects.
		Nuclear Technician/ 2-3	Tests nuclear waste dispoal methods.
		Sanitarian/4	Develops and executes environmental health program.
		Sewage Disposal Plant Operator/0	Operates equipment and monitors testing devices in sewage treatment plant.
		Sociologist/4-7	Aids in disseminating information on family planning.
		Urban Planner/4-6	Studies and plans for relief of urban problems.
		Waste Water Treatment Operator/0	Operates water pollution control equipment. Recycles water. Removes and disposes solid wastes.